IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Applicant(s):	Antoine Aneas
Appl. No.:	10/091,897
Conf. No.:	9171
Filed:	March 6, 2002
Title:	DEVICE FOR CONNECTION BETWEEN A RECIPIENT AND A CONTAINER, AND READY-TO-USE ASSEMBLY COMPRISING SUCH A DEVICE
Art Unit:	3763
Examiner:	Laura A. Bauchelle
Docket No.:	Baxter: BIO-5708; BBL: 112713-1346

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

APPEAL BRIEF

Sir:

Appellants submit this Appeal Brief in support of the Notice of Appeal filed on March 3, 2006. This Appeal is taken from the Final Rejection dated October 5, 2005.

I. Real Party in Interest

The real party in interest for the above-identified patent application on appeal is BIODOME by virtue of an Assignment dated February 18, 2002 and recorded at the United States Patent and Trademark Office at reel 013366, frame 0889.

II. Related Appeals And Interferences

Appellants, Appellant's legal representative and the Assignee of the above-identified patent application do not know of any prior or pending appeals, interferences or judicial proceedings which may be related to, directly affect or be directly affected by or have a bearing on the Board's decision with respect to the above-identified Appeal.

III. Status of the Claims

Claims 1-13 are pending in the above-identified patent application. Claims 1-13 stand rejected. Therefore, Claims 1-13 are being appealed in this Brief. A copy of the appealed claims is attached as Appendix A.

IV. Status of the Amendments

No amendments were made in this application after the final rejection.

V. Summary of the Claimed Subject Matter

A summary of the invention by way of reference to the drawings and specification for each of the independent claims (Claims 1, 12 and 13) may be found in the Table below:

Claim 1	Figures	Specification
Device for connection between a closed recipient and a container, said closed recipient comprising a neck whose opening is closed by a stopper, said connection device comprising: a base adapted to be mounted on said recipient and comprising a sleeve forming an inner bore (A), and	Fig. 2	¶29
a plunger adapted to slide in said bore, between a first position disengaged with respect to said stopper and	Fig. 2	¶13, abstract
a second so-called position of transfer, in which a hollow needle belonging to said plunger, traverses said stopper,	Fig. 7	¶ 35
wherein said needle presents a non-circular outer cross-section, while said sleeve presents a likewise non-circular inner cross-section, the outer section of said needle and inner section of said sleeve being such that said needle can slide in said sleeve, without the possibility of rotation of said needle in said sleeve, and	Fig. 3 Fig. 8	¶ 8, 9
an edge of said sleeve opposite said stopper is provided with stop means adapted to cooperate with a complementary means provided on said plunger to lock it in position of transfer.	Fig. 6 Fig. 7	¶ 35

Claim 12		
Ready-to-use assembly comprising a closed recipient containing a product, particularly a pharmaceutical preparation, said recipient being provided with a neck whose opening is closed by a stopper, and a connection device according mounted on said recipient, the connection device comprising: a base adapted to be mounted on said recipient and comprising a sleeve forming an inner bore (A), and	Fig. 2	¶ 29
a plunger adapted to slide in said bore, between a first position disengaged with respect to said stopper and	Fig. 2	¶ 13, abstract
a second so-called position of transfer, in which a hollow needle belonging to said plunger, traverses said stopper,	Fig. 7	¶ 35
wherein said needle presents a non-circular outer cross-section, while said sleeve presents a likewise non-circular inner cross-section, the outer section of said needle and inner section of said sleeve being such that said needle can slide in said sleeve, without the possibility of rotation of said needle in said sleeve, and	Fig. 3 Fig. 8	¶ 8, 9
an edge of said sleeve opposite said stopper is provided with stop means adapted to cooperate with a complementary means provided on said plunger to lock it in position of transfer.	Fig. 6 Fig. 7	¶ 35

Claim 13		
A connection device for connecting a closed recipient and a container, the closed recipient comprising a neck having an opening closed by a stopper, the connection device comprising: a base configured to be mounted on the recipient and having a sleeve forming an inner bore; and	Fig. 2	¶ 29
a plunger having a hollow needle, the plunger adapted to slide in said bore between a first position disengaged with respect to said stopper,	Fig 2	¶ 13, abstract
and a second position, wherein the hollow needle traverses said stopper,	Fig. 7	¶ 35
wherein said needle has a non-circular outer cross-section and said sleeve has a non-circular inner cross-section, the outer section of said needle and the inner section of said sleeve dimensioned such that said needle can slide in said sleeve without the possibility of rotation of said needle in said sleeve.	Fig. 3 Fig. 7	¶ 35

Although the citations are given in accordance with C.F.R. 1.192(c), these reference numerals and citations are merely examples of where support may be found in the specification for the terms used in this section of the Brief. There is no intention to suggest in any way that the terms of the claims are limited to the examples in the specification. As demonstrated by the references, numerals and citations below, the claims are fully supported by the specification as required by law. However, it is improper under the law to read limitations from the specification into the claims. Pointing out specification support for the claim terminology as is done here to comply with rule 1.192(c) does not in any way limit the scope of the claims to those examples

from which they find support. Nor does this exercise provide a mechanism for circumventing the law precluding reading limitations into the claims from the specification. In short, the references, numerals and specification citations are not to be construed as claim limitations or in any way used to limit the scope of the claims.

VI. Grounds of Rejection to be Reviewed on Appeal

1. Claims 1-8, 10, 12 and 13 stand rejected under 35 U.S.C. §103(a) as unpatentable over Aneas WO 98/13006 in view of Hiblar et al. US 2002/0072706 or Parker et al US 2003/0093037.

2. Claims 1-8, 10, 12 and 13 stand rejected under 35 U.S.C. §103(a) as unpatentable over Aneas WO 98/13006 in view of Parker et al US 2003/0093037.

3. Claim 11 stands rejected under 35 U.S.C. §103(a) as unpatentable over Aneas WO 98/13006 in view of Hiblar et al. US 2002/0072706 or Parker et al US 2003/0093037 and further in view of Thibault WO 99/53886.

4. Claim 9 stands rejected under Aneas WO 98/13006 in view of Hiblar et al. US 2002/0072706 or Parker et al US 2003/0093037 and further in view of Manera US Patent 6,706,031.

VII. Argument

A. Legal Standards

35 U.S.C. §103(a) states that:

> A patent may not be obtained.... if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains.

In making a determination that an invention is obvious, the Patent Office has the initial burden of establishing a *prima facie* case of obviousness. *In re Rijckaert*, 28 U.S.P.Q.2d 1955, 1956 (Fed. Cir. 1993). "If the examination at the initial stage does not produce a *prima facie* case of unpatentability, then without more, the applicant is entitled to grant of the patent." *In re Oetiker*, 24 U.S.P.Q.2d 1443, 1444 (Fed. Cir. 1992).

To establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the reference or references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. *In re Fine*, 5 U.S.P.Q.2d 1596 (Fed. Cir. 1988). Second there must be a reasonable expectation of success. *In re Merck & Co., Inc.*, 231 U.S.P.Q. 375 (Fed. Cir. 1986) Finally, all of the claim limitations must be taught or suggested by the prior art. *In re Royka*, 180 U.S.P.Q. 580 (CCPA 1974).

The initial burden is on the examiner to provide some suggestion of the desirability of doing what the inventor has done. To support the conclusion that the claimed invention is directed to obvious subject matter, either the references must expressly or impliedly suggest the claimed invention or the examiner must present a convincing line of reasoning as to why the artisan would have found the claimed invention to have been obvious in light of the teachings of the references. M.P.E.P. 2142 Moreover, a statement that modifications of the prior art to meet the claimed invention would have been "well within the ordinary skill of the art at the time the claimed invention was made" is not sufficient to establish a *prima facie* case of obviousness without some objective reason to combine the teachings of the references. M.P.E.P. 2143.01. It is "impermissible to use the claimed invention as an instruction manual or 'template' to piece together the teachings of the prior art so that the claimed invention is rendered obvious." *In re Fritch*, 23 U.S.P.Q.2d 1780, 1784 (Fed. Cir. 1992).

B. The Rejection of Claims 1-8, 10, 12 and 13 Under 35 U.S.C. §103(a) Over *Aneas* WO 98/13006 in view of *Hiblar* et al. US 2002/0072706 Should Be Reversed Because the Office Action Does Not Establish a *Prima Facie* Case of Obviousness

Claims 1-8, 10, 12 and 13 stand rejected under 35 U.S.C. 103(a) as being unpatentable over WO 98/13006 (*Aneas*), attached as Appendix B, in view of US 2002/0072706 (*Hiblar et al.),* attached as Exhibit C. In the Office action *Aneas* is said to disclose a drug reconstitution device for connection between a closed recipient and a container comprising a neck whose opening is closed by a stopper. *Aneas* is said to disclose a base adapted to be mounted on a recipient 3 and comprising a sleeve with an inner bore 12a and further, a hollow needle 5 and plunger 15, adapted to slide in the bore and has an edge of sleeve opposite a stopper 3b provided with stop means 18 adapted to cooperate with complementary means 16 provided on the plunger

15 to lock it in a transfer position. *Hiblar* is said to disclose a needle with a non-circular cross section 30 in conjunction with a non-circular sleeve 34 in order to prevent rotation of the needle within the sleeve. The Office action concluded that it would have been obvious to modify the needle of *Aneas* to have the non-circular needle and sleeve of *Hiblar* to prevent unwanted rotation of the *Aneas* needle.

In *Aneas* the perforating means ("needle") is attached to a plunger that has ribs that engage corresponding grooves on skirt 12 to prevent axial rotation of its piercing member. (see Figure 1 and column 4, lines 41-47 of US Patent No. 6,070,623 (Appendix B) which corresponds to page 7, line 22 – Page 8, line 8 of WO 98/13006 (Appendix B)) In contrast, each of the independent claims 1, 12 and 13 contains the following phrase:

> needle presents a non-circular outer cross-section, while said sleeve presents a likewise non-circular inner cross-section, the outer section of said needle and inner section of said sleeve being such that said needle can slide in said sleeve, without the possibility of rotation of said needle in said sleeve ...

Principally, the structure set forth in claims 1, 12 and 13 prevents axial rotation of the needle as it pierces the stopper of the drug vial. Given that the *Aneas* reconstitution device already has a mechanism that prevents axial rotation of its piercing member that does not involve a needle having a non-circular outer cross section, there is no convincing reason as to why components of the *Hiblar* catheter should be combined with the *Aneas* reconstitution device to provide *Aneas* with a needle having a non-circular outer cross-section and sheeth with a non-circular inner cross-section to prevent "the possibility of rotation of said needle in said sleeve." Even if a way could be found to include both mechanisms, such a combination would provide a redundant solution to the problem of axial rotation of the piercing member that would add cost to the manufacture of such a device without adding any benefit. Applicant also notes that considerations with respect to the design of reconstitution devices, like the *Aneas*, are not the same as catheter design considerations, as in the *Hiblar*, and the distinctive nature of these arts fails to support their combination. In summary, there is no teaching or motivation provided in *Hiblar* or *Aneas* to support their combination and no other reasons are given in the Office action that would lead one of skill in the art to combine *Aneas* and *Hiblar* in such a way as to obtain the present invention.

To support a *prima facie* case of obviousness there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of

ordinary skill in the art to modify the reference and the initial burden is on the examiner to provide some suggestion of the desirability of doing what the inventor has done. Applicant submits that the requisite motivation is simply not present in this case and that therefore a *prima facie* case of obviousness has not been established. It appears that the invention has impermissibly been used as a template to piece together teachings of the prior art to arrive at the present rejection for obviousness. Because all the independent claims contain the recited language, all of the pending claims contain this phrase, therefore Applicants request that this rejection be withdrawn.

C. The Rejection of Claims 1-8, 10, 12 & 13 Under 35 U.S.C. §103(a) Over *Aneas* WO 98/13006 in view of *Parker* et al US 2003/0093037 Should Be Reversed Because the Office Action Does Not Establish a *Prima Facie* Case of Obviousness

Claims 1-8, 10, 12 and 13 stand rejected under 35 U.S.C. 103(a) as being unpatentable over *Aneas,* attached as Appendix B, in view of US 2003/0093037 (*Parker et al.*), attached as Exhibit D. In the Office action *Aneas* is said to disclose a drug reconstitution device for connection between a closed recipient and a container comprising a neck whose opening is closed by a stopper. *Aneas* is said to disclose a base adapted to be mounted on a recipient 3 and comprising a sleeve with an inner bore 12a and further, a hollow needle 5 and plunger 15, adapted to slide in the bore and has an edge of sleeve opposite a stopper 3b provided with stop means 18 adapted to cooperate with complementary means 16 provided on the plunger 15 to lock it in a transfer position. *Parker* is said to disclose a hypodermic needle syringe having a non-circular hub 4 and non-circular sleeve 12 in order to prevent axial rotation of the needle relative to the sleeve. The present rejection is premised on the Office action's position that the *Parker* non-circular hub and sleeve in combination with *Aneas* renders obvious the present claims which require a needle with a non-circular outer cross-section and sleeve which presents a likewise non-circular inner cross-section such that said needle can slide in said sleeve, without the possibility of rotation of said needle in said sleeve.

Each of the claims in the pending application clearly recites a needle with a non-circular outer cross-section which is not found in either *Aneas* or in *Parker.* The law requires that to establish a prima facie case of obviousness all of the claim limitations must be taught or suggested by the prior art and there must be some suggestion or motivation, either in the

references themselves or in the knowledge generally available to one of ordinary skill in the art to modify the reference or to combine reference teachings to obtain the claimed invention. This rejection should be reversed because even if *Aneas* could be combined with *Parker,* the combination would not contain all of the limitations of the claims.

The rejection should be reversed for another reason. In *Aneas* the perforating means ("needle") is attached to a plunger that has ribs that engage corresponding grooves on skirt 12 to prevent axial rotation of its piercing member. (See Figure 1 and column 4, lines 41-47 of US Patent No. 6,070,623 (Appendix B) which corresponds to page 7, line 22 – Page 8, line 8 of WO 98/13006 (Appendix B)) *Aneas* lacks a non-circular needle. Similarly, in *Parker* a non-circular sleeve 12 engages a non-circular hub to block axial rotation of its piercing member. *Parker* lacks a non-circular needle. Both *Aneas* and *Parker* block axial rotation of their respective piercing members, yet neither use non-circular needles as in the present claims. Because the references lack all of the required limitations, they can provide no motivation or suggestion for their combination in a manner that would give all the limitations of the present claims. Furthermore, there is no incentive to add a non-circular needle to either *Aneas* or *Parker* in order to obtain a device that prevents axial rotation of a piercing member, because axial rotation of the piercing member is already blocked in the devices disclosed in those patents. In addition, the combination itself, even if proper, would provide for redundant mechanisms for blocking axial rotation of the piercing member and would not provide any motivation for adding yet a third undisclosed mechanism, namely a non-circular needle in a non-circular sheeth for preventing axial rotation of the piercing member. Because each of the independent claims, 1, 12 and 13, contain the recited language Applicants request that the rejection be withdrawn from all the claims of this case.

D. The Rejection Of Claim 11 Under 35 U.S.C. §103(A) Over *Aneas* WO 98/13006 In View Of *Hiblar* et al. US 2002/0072706 Or Parker et al US 2003/0093037 and Further in View Of *Thibault* WO 99/53886 Should Be Reversed Because the Office Action Does Not Establish A *Prima Facie* Case of Obviousness

Claim 11 was rejected as obvious over *Aneas* in view of *Hiblar* or *Parker* and further in view of *Thibault* (WO 99/53886), attached as Appendix E. Claim 11 is believed to be allowable for the reasons stated above with respect to *Aneas*, *Hiblar*, and *Parker*. The teaching of *Thibault*

does not impinge on those arguments. In short, *Thibault* also fails to teach or suggest a needle presenting a non-circular outer cross-section, while said sleeve presents a likewise non-circular inner cross-section, the outer section of said needle and inner section of said sleeve being such that said needle can slide in said sleeve, without the possibility of rotation of said needle in said sleeve. Thus, Applicant requests this rejection be reversed.

E. The Rejection Of Claim 11 Under 35 U.S.C. §103(A) Over *Aneas* WO 98/13006 In View Of *Hiblar* et al. US 2002/0072706 Or *Parker* et al US 2003/0093037 and Further in View Of *Manera* US Patent 6,706,031 Should Be Reversed Because the Office Action Does Not Establish A *Prima Facie* Case of Obviousness

Claim 9 was rejected as obvious over *Aneas* in view of *Hiblar* or *Parker* and further in view of *Manera* (US 6,706,031), attached as Appendix F. Claim 9 is believed to be allowable for the reasons stated above with respect to *Aneas*, *Hiblar*, and *Parker*. The teaching of *Manera* does not impinge on those arguments. In short, *Manera* also fails to teach or suggest a needle presenting a non-circular outer cross-section, while said sleeve presents a likewise non-circular inner cross-section, the outer section of said needle and inner section of said sleeve being such that said needle can slide in said sleeve, without the possibility of rotation of said needle in said sleeve. Thus, Applicant requests this rejection be reversed.

VIII. Conclusion

Appellants' submit that there is no suggestion or motivation for the combination of *Aneas* with *Hilbar* because the problem solved by the present application is lacking in those references and there simply is no motivation to combine them in a manner that would give the presently claimed invention. Similarly, there is no motivation for the combination of *Aneas* with *Parker* and even if those references were combined, the combination would lack all the elements of the claimed invention, namely the non-circular needle of the present claims. Neither *Thibault* nor *Manera* contain such teachings or any further motivation for a combination that could support a rejection for obviousness. Thus, it is submitted that the pending rejections for obviousness are erroneous in law and in fact and should be reversed by this Board.

Respectfully submitted,

BELL, BOYD & LLOYD LLC

BY 

Robert M. Gould
Reg. No. 43,642
Customer No. 29200

Dated: June 20, 2006

APPENDIX A

PENDING CLAIMS OF U.S. PATENT APPLICATION SERIAL NO. 10/091,897

Claim 1: Device for connection between a closed recipient and a container, said closed recipient comprising a neck whose opening is closed by a stopper, said connection device comprising:

a base adapted to be mounted on said recipient and comprising a sleeve forming an inner bore (A), and

a plunger adapted to slide in said bore, between a first position disengaged with respect to said stopper and a second so-called position of transfer, in which a hollow needle belonging to said plunger, traverses said stopper,

wherein said needle presents a non-circular outer cross-section, while said sleeve presents a likewise non-circular inner cross-section, the outer section of said needle and inner section of said sleeve being such that said needle can slide in said sleeve, without the possibility of rotation of said needle in said sleeve, and

an edge of said sleeve opposite said stopper is provided with stop means adapted to cooperate with a complementary means provided on said plunger to lock it in position of transfer.

Claim 2: The device of Claim 1, wherein said needle presents an oval outer cross-section while the inner cross-section of said sleeve is oval.

Claim 3: The device of Claim 1, wherein said needle presents a polygonal outer cross-section, while the inner cross-section of said sleeve is polygonal, with the same number of sides as said outer section of said needle.

Claim 4: The device of Claim 1, wherein said stop means provided on said edge of said sleeve comprises elastically deformable hooks while said complementary means provided on said plunger comprises bearing surfaces made on a flange in one piece with said needle, said needle and said flange together constituting said plunger.

Claim 5: The device of Claim 4, wherein said flange is provided with openings for passage of said hooks.

Claim 6: The device of Claim 4, wherein said hooks are each provided with a nose adapted to be imbricated with a return bordering one of the bearing surfaces made on said flange.

Claim 7: The device of Claim 4, wherein said hooks project radially towards the outside with respect to said sleeve.

Claim 8: The device of Claim 1, wherein said base comprises a second sleeve disposed radially outside said sleeve, said second sleeve being adapted to cooperate with a cap for protecting said plunger with respect to the ambient atmosphere.

Claim 9: The device of Claim 8, further comprising rigidifying ribs connecting said sleeves.

Claim 10: The device of Claim 1, further comprising means for temporarily stopping said plunger in said disengaged position.

Claim 11: The device of Claim 10, wherein said means comprises at least one hollow made on the outer surface of said needle and at least one projection extending, from the inner radial surface of said sleeve, in the direction of a central axis (X-X') of said bore (A), said projection being adapted to be engaged in said hollow and to maintain said plunger in said first position.

Claim 12: Ready-to-use assembly comprising a closed recipient containing a product, particularly a pharmaceutical preparation, said recipient being provided with a neck whose opening is closed by a stopper, and a connection device mounted on said recipient, the connection device comprising:

a base adapted to be mounted on said recipient and comprising a sleeve forming an inner bore (A), and

a plunger adapted to slide in said bore, between a first position disengaged with respect to said stopper and a second so-called position of transfer, in which a hollow needle belonging to said plunger, traverses said stopper,

wherein said needle presents a non-circular outer cross-section, while said sleeve presents a likewise non-circular inner cross-section, the outer section of said needle and inner section of said sleeve being such that said needle can slide in said sleeve, without the possibility of rotation of said needle in said sleeve, and

an edge of said sleeve opposite said stopper is provided with stop means adapted to cooperate with a complementary means provided on said plunger to lock it in position of transfer.

Claim 13: A connection device for connecting a closed recipient and a container, the closed recipient comprising a neck having an opening closed by a stopper, the connection device comprising:

a base configured to be mounted on the recipient and having a sleeve forming an inner bore; and

a plunger having a hollow needle, the plunger adapted to slide in said bore between a first position disengaged with respect to said stopper, and a second position, wherein the hollow needle traverses said stopper,

wherein said needle has a non-circular outer cross-section and said sleeve has a non-circular inner cross-section, the outer section of said needle and the inner section of said sleeve dimensioned such that said needle can slide in said sleeve without the possibility of rotation of said needle in said sleeve.

APPENDIX B

WO 98/13006 ("*Aneas*") & Corresponding US 6,070623

PCT ORGANISATION MONDIALE DE LA PROPRIETE INTELLECTUELLE
Bureau international

DEMANDE INTERNATIONALE PUBLIEE EN VERTU DU TRAITE DE COOPERATION EN MATIERE DE BREVETS (PCT)

(51) Classification internationale des brevets 6 : A61J 1/20 — A1

(11) Numéro de publication internationale: **WO 98/13006**

(43) Date de publication internationale: 2 avril 1998 (02.04.98)

(21) Numéro de la demande internationale: PCT/FR97/01676

(22) Date de dépôt international: 24 septembre 1997 (24.09.97)

(30) Données relatives à la priorité:
96/11965 25 septembre 1996 (25.09.96) FR

(71) Déposant (*pour tous les Etats désignés sauf US*): BIODOME [FR/FR]; Parc Technologique de la Béchade, Z.I. de Lavaur, F-63500 Issoire (FR).

(72) Inventeur; et
(75) Inventeur/Déposant (*US seulement*): ANEAS, Antoine [FR/FR]; 7, impasse Voltaire, F-63200 Menetrol (FR).

(74) Mandataires: MYON, Gérard etc.; Cabinet Lavoix Lyon, 62, rue de Bonnel, F-69448 Lyon Cedex 03 (FR).

(81) Etats désignés: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, brevet ARIPO (GH, KE, LS, MW, SD, SZ, UG, ZW), brevet eurasien (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), brevet européen (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), brevet OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

Publiée
Avec rapport de recherche internationale.

(54) Title: CONNECTING DEVICE, IN PARTICULAR BETWEEN A RECEPTACLE WITH A STOPPER CAPABLE OF BEING PERFORATED AND A SYRINGE

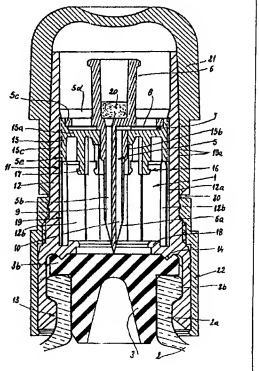
(54) Titre: DISPOSITIF DE CONNEXION, EN PARTICULIER ENTRE UN RECIPIENT AVEC BOUCHON PERFORABLE ET UNE SERINGUE

(57) Abstract

The invention concerns a connecting device (1) between a first receptacle (2), and a second receptacle (4) comprising a muff joint (4a), said device comprising means (5) for perforating a stopper, including a faucet (6) and a filtering chamber (7) isolated from outside by a filter (8), two independent channels (9, 10) being provided in the perforating means (5) for communicating the inside of the first receptacle (2) with the faucet (6) and the filtering chamber (7) respectively, said device further comprising means (11) for displacing with guidance the perforating means (5), means for fastening (13) the skirt (12) on the neck (2a), a plunger (15) mounted in the internal bore (12a) on which the perforating means (5) are fixed, for sliding by simple pressure, and means (16) for definitively stopping the plunger (15).

(57) Abrégé

Dispositif de connexion (1) entre un premier récipient (2), et un deuxième récipient (4) comprenant un embout mâle (4a), ledit dispositif comprenant un moyen (5) de perforation du bouchon, comportant d'une part, un embout femelle (6), et d'autre part une chambre (7) de filtration isolée par rapport à l'extérieur par un filtre (8), deux canaux (9, 10) indépendants étant ménagés dans le moyen de perforation (5) pour établir une communication entre l'intérieur du premier récipient (2) et respectivement l'embout femelle (6) et la chambre de filtration (7), ledit dispositif comprenant en outre des moyens (11) de déplacement avec guidage du moyen de perforation (5), des moyens d'accrochage (13) de la collerette (12) sur le col (2a), un piston (15) monté dans l'alésage interne (12a) sur lequel est fixé le moyen de perforation (5), pour coulisser par simple poussée, et des moyens (16) d'arrêt définitif du piston (15).



UNIQUEMENT A TITRE D'INFORMATION

Codes utilisés pour identifier les Etats parties au PCT, sur les pages de couverture des brochures publiant des demandes internationales en vertu du PCT.

AL	Albanie	**ES**	Espagne	**LS**	Lesotho	**SI**	Slovénie
AM	Arménie	**FI**	Finlande	**LT**	Lituanie	**SK**	Slovaquie
AT	Autriche	**FR**	France	**LU**	Luxembourg	**SN**	Sénégal
AU	Australie	**GA**	Gabon	**LV**	Lettonie	**SZ**	Swaziland
AZ	Azerbaïdjan	**GB**	Royaume-Uni	**MC**	Monaco	**TD**	Tchad
BA	Bosnie-Herzégovine	**GE**	Géorgie	**MD**	République de Moldova	**TG**	Togo
BB	Barbade	**GH**	Ghana	**MG**	Madagascar	**TJ**	Tadjikistan
BE	Belgique	**GN**	Guinée	**MK**	Ex-République yougoslave de Macédoine	**TM**	Turkménistan
BF	Burkina Paso	**GR**	Grèce			**TR**	Turquie
BG	Bulgarie	**HU**	Hongrie	**ML**	Mali	**TT**	Trinité-et-Tobago
BJ	Bénin	**IE**	Irlande	**MN**	Mongolie	**UA**	Ukraine
BR	Brésil	**IL**	Israël	**MR**	Mauritanie	**UG**	Ouganda
BY	Bélarus	**IS**	Islande	**MW**	Malawi	**US**	Etats-Unis d'Amérique
CA	Canada	**IT**	Italie	**MX**	Mexique	**UZ**	Ouzbékistan
CF	République centrafricaine	**JP**	Japon	**NE**	Niger	**VN**	Viet Nam
CG	Congo	**KE**	Kenya	**NL**	Pays-Bas	**YU**	Yougoslavie
CH	Suisse	**KG**	Kirghizistan	**NO**	Norvège	**ZW**	Zimbabwe
CI	Côte d'Ivoire	**KP**	République populaire démocratique de Corée	**NZ**	Nouvelle-Zélande		
CM	Cameroun			**PL**	Pologne		
CN	Chine	**KR**	République de Corée	**PT**	Portugal		
CU	Cuba	**KZ**	Kazakstan	**RO**	Roumanie		
CZ	République tchèque	**LC**	Sainte-Lucie	**RU**	Fédération de Russie		
DE	Allemagne	**LI**	Liechtenstein	**SD**	Soudan		
DK	Danemark	**LK**	Sri Lanka	**SE**	Suède		
EE	Estonie	**LR**	Libéria	**SG**	Singapour		

DISPOSITIF DE CONNEXION, EN PARTICULIER ENTRE UN RECIPIENT AVEC BOUCHON PERFORABLE ET UNE SERINGUE

La présente invention concerne de manière générale la connexion entre, d'un côté un premier récipient comprenant un col obturé par un bouchon perforable visco-élastique, et de l'autre côté un deuxième récipient comprenant un embout mâle.

Plus particulièrement, mais à titre non exclusif, la présente invention sera introduite, définie et décrite par référence à la connexion entre, d'un côté un premier récipient constitué par un flacon rigide, par exemple en verre, dont le col est obturé de manière étanche par un bouchon en caoutchouc perforable, et de l'autre côté un deuxième récipient, toujours rigide, constitué par une seringue, comportant elle-même de manière traditionnelle un corps tubulaire rigide se terminant par un embout mâle, du type "luer lock" par exemple, et un piston monté de manière étanche et coulissante à l'intérieur du corps tubulaire. Une connexion telle que définie précédemment est en particulier requise lorsqu'il s'agit de préparer une solution ou suspension médicamenteuse à partir d'un principe actif sous forme de poudre ou de lyophilisat, contenu par le premier récipient, à savoir le flacon, et d'un milieu liquide, par exemple une solution, contenue dans le deuxième récipient, c'est-à-dire dans la seringue. En pareil cas, de manière générale, les opérations suivantes sont mises en oeuvre :

- le premier récipient (flacon) étant activé, et le second récipient (seringue) étant rempli avec le milieu liquide, on perfore le bouchon avec un moyen de perforation approprié, appartenant ou non à la seringue, pour établir une communication entre les deux récipients,

- on introduit le milieu liquide du second récipient (seringue) à l'intérieur du premier récipient (flacon), pour mélanger le milieu liquide et le principe actif en poudre ou lyophilisat, la seringue étant dans ce cas disposée au dessus du flacon,

- la dissolution ou mise en suspension étant complète à l'intérieur du premier récipient (flacon), on retourne l'ensemble constitué par le flacon et la seringue connectés l'un à l'autre par l'intermédiaire du moyen de perforation, pour disposer le premier récipient au-dessus du second récipient,

- et en tirant le piston de la seringue, on extrait la suspension ou solution du principe actif, du premier récipient pour l'introduire dans le second récipient,

- dès lors la seringue comportant la suspension ou solution du principe actif est prête à être utilisée, éventuellement après mise en place d'une aiguille d'injection sur l'embout mâle de ladite seringue.

Aux fins de connecter deux récipients tels que définis et exemplifiés précédemment, conformément au document EP-A-0 126 718, on a déjà proposé un dispositif de transfert avec perforation du bouchon comportant :

- d'une part un embout femelle de jonction étanche, par exemple un cône du type "luer lock", de jonction étanche avec l'embout mâle du deuxième récipient, et d'autre part une chambre de filtration isolée par rapport à l'extérieur par un filtre, par exemple un filtre absolu permettant de stériliser tout flux gazeux ou liquide le traversant dans un sens ou dans l'autre,

- deux canaux indépendants ménagés dans ledit moyen de perforation pour établir une communication entre l'intérieur du premier récipient et respectivement l'embout femelle et la chambre de filtration, dans la position où le moyen de perforation perfore le bouchon, de manière étanche par rapport à l'extérieur.

Ce dispositif de connexion comprend en outre des moyens de déplacement avec guidage du moyen de perforation, constitués au moins par une collerette ménageant un alésage interne ;

- des moyens d'accrochage de la collerette sur le col du premier récipient, pour aboutir à une position accrochée dans laquelle l'alésage interne débouche sur le bouchon ;

- des moyens d'étanchéité de l'alésage interne par rapport à l'extérieur, dans la position accrochée de la collerette ;

- un piston sur lequel est fixé ou auquel appartient le moyen de perforation, ceci pour coulisser par simple poussée, d'une position inactivée dans laquelle l'extrémité perforante est à l'écart du bouchon, à une position perforante ou de perforation dans laquelle cette même extrémité perforante a traversé le bouchon,

Un tel dispositif autorise tout mouvement relatif non contrôlé, entre les deux récipients en cours de connexion ou connectés, de telle sorte qu'il est difficile de maîtriser avec précision la quantité de milieu liquide ou liquide, introduite dans le premier récipient ou extraite de ce dernier, par l'intermédiaire du mouvement relatif entre le piston et le corps tubulaire de la seringue (deuxième récipient) par exemple.

La présente invention a donc pour objet une solution permettant de mieux contrôler le mouvement relatif entre le premier récipient et le second récipient, lorsqu'ils sont connectés, de manière en particulier à minimiser et à rendre constant le volume mort, c'est-à-dire du liquide qui ne peut être soutiré du premier récipient, après connexion des deux récipients.

Conformément à la présente invention, le dispositif de connexion comprend en outre :

- des moyens d'arrêt du piston, définitivement dans la position perforante, ces moyens comportant un organe d'encliquetage disposé sur ou du côté du piston, et un organe complémentaire d'arrêt, disposé sur ou du côté de la collerette, l'organe d'encliquetage comportant une pluralité de dents distribuées autour de l'axe du psiton,

élastiques pur être rappelées de manière centrifuge ou centripète, l'organe complémentaire d'arrêt consistant en un flanc annulaire contre lequel se bloquent desdites dents.

La présente invention fait référence au dessin annexé, dans lequel :

- la figure 1 représente, en coupe transversale, un dispositif de connexion conforme à la présente invention, en position accrochée et verrouillée sur un premier récipient, et dans la position inactivée du piston comportant le moyen de perforation ; sur cette figure, le dispositif de connexion est également représenté avec son capuchon, maintenant une étanchéité de l'intérieur du dispositif de connexion par rapport à l'extérieur,

- la représentation de la figure 2 diffère de celle de la figure 1, en ce que le capuchon a été retiré, et le second récipient est embouché sur le moyen de perforation, dans la position inactivée de ce dernier,

- la représentation de la figure 3 diffère de celle de la figure 2, en ce que le piston et son moyen de perforation sont dans la position activée, ou perforante, avec introduction du liquide contenu par le deuxième récipient dans le premier récipient, dans cet exemple en appuyant sur le piston de la seringue constituant le second récipient,

- la représentation de la figure 4 diffère de celle de la figure 3, en ce que l'ensemble des deux récipients connectés est retourné, et le liquide contenu dans le premier récipient est soutiré dans le second récipient, en tirant sur le piston de la seringue par exemple.

Conformément aux figures 1 et 2, le dispositif de connexion décrit ci-après permet de connecter de manière étanche par rapport à l'extérieur, et notamment en préservant des conditions pré-établies de stérilité :

- d'un côté, un premier récipient 2 par exemple un flacon en verre, comprenant un col 2a avec un bourrelet annulaire 2b, obturé par un bouchon 3 en matériau visco-élastique (caoutchouc), perforable, et comportant lui-même une partie épaulée 3b reposant à plat sur le bourrelet annulaire 2b du premier récipient ; par hypothèse et en utilisation, ce flacon contient dans des conditions d'étanchéité (notamment par rapport à tout liquide extérieur), et de stérilité, une poudre ou lyophilisat d'un principe actif par exemple,

- et de l'autre côté un deuxième récipient, comprenant un embout mâle 4a, constitué par exemple par une seringue traditionnelle, comportant un corps tubulaire 4b, un cône du type "luer lock", rapporté sur une extrémité du corps tubulaire 4b, formant l'embout mâle précité, et un piston 21 permettant à volonté de remplir ou vider la seringue.

Le dispositif de connexion proprement dit, conforme à l'invention, permettant de relier les deux récipients exemplifiés précédemment, par perforation du bouchon 3, comprend de manière générale :

- un moyen 5 de perforation du bouchon,

- des moyens 11 de déplacement avec guidage du moyen de perforation précité, constitués au moins par une collerette 12 et un piston 15 sur lequel est monté ou auquel appartient le moyen de perforation 5,

- des moyens d'accrochage 13 de la collerette 12 sur le col 2a du premier récipient,

- des moyens d'étanchéité 14 de l'intérieur de la collerette 12, par rapport à l'extérieur, mettant en oeuvre les caractéristiques visco-élastiques de la partie supérieure du bouchon 3,

- et des moyens d'arrêt 16 définitifs du piston 15 dans la position perforante ou de perforation, représentée par exemple aux figures 3 et 4.

Le moyen 5 de perforation comporte, comme représenté la figure 1, une partie centrale ou axiale 5b se terminant par une extrémité perforante 5a, un collet 5c permettant la fixation des moyens de perforation sur le piston défini ci-après, dans lequel une ouverture circonférentielle 5d est ménagée, et un embout femelle 6, prolongeant la partie axiale 5b, et permettant d'assurer une jonction étanche avec l'embout mâle 4a du deuxième récipient (seringue). Au niveau du moyen de perforation 5, à l'opposé de l'extrémité perforante 5a ci-après, une chambre de filtration 7 est ménagée entre un embrèvement prévu dans le piston 15, défini ci-après, et un filtre 8, maintenu serré entre le collet 5c et un épaulement correspondant prévu sur le piston 15, et isolant ladite chambre par rapport à l'extérieur. L'embout femelle 6, disposé du côté opposé à l'extrémité perforante 5a, comporte un filtre 20 pour la filtration de tout liquide le traversant dans un sens ou dans l'autre. Deux canaux 9 et 10, indépendants, sont ménagés dans la partie axiale 5b du moyen de perforation 5, pour établir une communication entre l'intérieur du premier récipient 2 et respectivement l'embout femelle 6 et la chambre de filtration 7, dans la position perforante ou de perforation, représentée aux figures 2 à 4 par exemple, dans laquelle le moyen 5 de perforation perfore le bouchon 4, en l'ayant traversé complètement par son extrémité perforante 5a.

Les moyens 11 de déplacement avec guidage du moyen de perforation 5 sont constitués par la coopération de la collerette 12 tubulaire, ménageant un alésage interne 12a, et du piston 15 monté dans l'alésage interne 12a, sur lequel est fixé ou monté le moyen de perforation 5. La collerette 12 est obtenue de manière monobloc avec les moyens d'accrochage 13, par exemple en matière plastique, et comme représenté sur la figure 1 peut s'étendre vers le haut, au-delà de l'extrémité libre de l'embout femelle 6, afin d'empêcher un actionnement accidentel du piston par

les doigts de l'utilisateur. Par ailleurs, elle est munie d'une capsule formant moyens d'accrochage 13, susceptible de s'encliqueter par rapport et sous le rebord annulaire 2b du récipient 2, au contact du col 2a, et ceci grâce à une élasticité radiale lui permettant de rappeler le bord inférieur circonférentiel en position centripète. En pratique, cette capsule d'accrochage 13 est constituée par une pluralité de dents d'accrochage, formant ensemble la capsule définie précédemment, et disposant chacune de l'élasticité radiale précitée. Dans la position accrochée représentée aux figures 1 à 4, l'alésage interne 12a débouche sur le bouchon 3, et plus particulièrement sa partie supérieure accessible à l'extrémité perforante 5a du moyen de perforation 5. Des moyens d'étanchéité 14 de l'alésage interne 12a, par rapport à l'extérieur, et utilisant les propriétés visco-élastiques du bouchon 3, sont construits de manière monobloc également avec la collerette 12 ; ces moyens consistent notamment en une nervure circonférentielle continue, relativement dure et pénétrant au moins partiellement dans le matériau relativement mou du bouchon 3.

Le piston 15 comporte une âme transversale 15a comportant un orifice épaulé 15b permettant le passage de la partie axiale 5b du moyen de perforation 5, avec retenue axiale dudit moyen. Comme dit précédemment, le moyen de perforation 5 est par ailleurs retenu de manière étanche par son collet 5c, sur l'épaulement défini par l'embrèvement de la chambre de filtration 7. En étant bloqué en rotation par rapport à la collerette 12 par les moyens définis ci-après, le piston 15, monté dans l'alésage interne 12a, peut coulisser par simple poussée axiale, d'une position inactivée (Cf. figures 1 et 2) dans laquelle l'extrémité perforante 5a est à l'écart du bouchon 3, et une position perforante (Cf. figures 3 et 4), dans laquelle l'extrémité perforante 5a a complètement traversée le bouchon 3. Les moyens de blocage 19 en

rotation du piston 15 par rapport à la collerette 12 sont obtenus en ménageant, du côté de la collerette 12 sur sa surface interne, huit rainures parallèles à l'axe du dispositif, réparties sur le pourtour de ladite collerette, et du côté du piston huit nervures correspondantes, non représentées, susceptibles de s'engager respectivement dans les rainures précitées.

Les moyens 16 d'arrêt définitif du piston 15 et par conséquent les moyens de perforation 5, dans la position perforante, dans laquelle l'extrémité perforante du moyen 5 a complètement traversé le bouchon 3, comportent :

- un ou plusieurs organes d'encliquetage 17, appartenant au piston 5, constitués par des dents distribuées autour de l'axe du piston 15, élastiques pour être rappelées de manière centrifuge ou centripète ; ces organes d'encliquetage 17 forment ensemble une couronne concentrique avec l'axe du piston 15, à l'intérieur de la collerette 15c assurant le coulissement du piston dans l'alésage interne 12a,

- et un ou plusieurs organes complémentaires d'arrêt 18, disposés sur la collerette 12, consistant par exemple en un flanc annulaire 18, contre lequel ou sous lequel se bloquent les dents 17, lorsque le piston 15 est déplacé vers le bouchon 3.

Le capuchon 21 est monté sur la collerette 12, de manière étanche, pour contenir l'embout femelle 6 et les autres parties internes du dispositif, à savoir le piston 15 et le moyen de perforation 5, de manière isolée par rapport à l'extérieur, ceci en fermant de manière étanche la partie interne de la collerette 12, opposée au bouchon 3. Cette étanchéité est obtenue en particulier grâce à une succession de lamelles circonférentielles 19a ménagées sur la surface externe de la collerette 12, et sur lesquelles se bloque le capuchon 21.

Par "étanchéité", on entend une étanchéité par rapport au moins aux liquides, et permettant en particulier de maintenir des conditions de stérilité à l'intérieur du dispositif de connexion.

Par ailleurs, le dispositif de connexion selon l'invention est fixé de manière définitive sur le premier récipient 2. A cette fin, il intègre des moyens 22 de verrouillage définitif du dispositif sur le premier récipient 2, bloquant les moyens d'accrochage 13 dans leur position accrochée sur le col 2a du récipient 2. Ces moyens de verrouillage consistent en particulier en une bague externe, construite de manière monobloc avec le capuchon 21, mais séparée de ce dernier par une ligne d'affaiblissement 30 permettant de séparer le capuchon du dispositif de connexion.

Le fonctionnement du dispositif de connexion 1 selon la présente invention se déduit des représentations des figures 2 à 4, explicitées par référence à l'énumératif des figures, et au deuxième paragraphe de la présente description.

Un dispositif tel que précédemment décrit présente en outre différents avantages importants :

- il est à usage unique, puisqu'en particulier les moyens 16 d'arrêt définitif du piston 15 excluent une autre réutilisation,

- il assure une sécurité d'utilisation totale, l'utilisateur ne pouvant à aucun moment toucher l'extrémité perforante 5a du moyen de perforation 5, avec ses doigts, puisqu'en particulier le déplacement et guidage du piston 15 ne nécessitent aucune autre intervention que sa poussée par l'embout mâle de la seringue,

- l'utilisateur n'a aucun besoin fonctionnel de toucher le piston 15 et/ou le moyen de perforation 5 avec ses doigts, et en particulier il n'existe aucun risque de blessure accidentelle.

REVENDICATIONS

1./ Dispositif de connexion (1) entre d'un côté un premier récipient (2) comprenant un col (2a) obturé par un bouchon (3) perforable visco-élastique, et de l'autre côté un deuxième récipient (4) comprenant un embout mâle (4a), ledit dispositif comprenant un moyen (5) de perforation du bouchon, comportant du côté opposé à l'extrémité perforante (5a) dudit moyen de perforation, d'une part un embout femelle (6) de jonction étanche avec l'embout mâle (4a) du deuxième récipient (4), et d'autre part une chambre (7) de filtration isolée par rapport à l'extérieur par un filtre (8), deux canaux (9, 10) indépendants étant ménagés dans le moyen de perforation (5) pour établir une communication entre l'intérieur du premier récipient (2) et respectivement l'embout femelle (6) et la chambre de filtration (7), dans la position où le moyen de perforation (5) perfore le bouchon (4), ledit dispositif comprenant en outre des moyens (11) de déplacement avec guidage du moyen de perforation (5), constitués au moins par une collerette (12) ménageant un alésage interne (12a), des moyens d'accrochage (13) de la collerette (12) sur le col (2a) du premier récipient (2) dans une position accrochée dans laquelle l'alésage (12a) interne débouche sur le bouchon (3), avec des moyens d'étanchéité (14) de l'alésage interne (12a) par rapport à l'extérieur, un piston (15) sur lequel est fixé le moyen de perforation (5), pour coulisser par simple poussée d'une position inactive (Fig. 1 et 2) dans laquelle l'extrémité perforante (5a) est à l'écart du bouchon (3), et une position perforante (Fig. 3 et 4) dans laquelle ladite extrémité perforante (5a) a traversé le bouchon (3), **caractérisé en ce que** le dispositif comrpend en outre des moyens (16) d'arrêt définitif du piston (15) dans la position perforante, comportant un organe d'encliquetage (17) sur le piston, et un organe complémentaire d'arrêt (18) sur la collerette, l'organe d'encliquetage comportant

une pluralité de dents (17) distribuées autour de l'axe du piston (15), élastiques pour être rappelées de manière centrifuge ou centripète, et l'organe complémentaire d'arrêt consistant en un flanc (18) annulaire contre lequel se bloquent lesdites dents (17).

2./ Dispositif selon la revendication 1, caractérisé en ce que des moyens (19) de blocage en rotation sont ménagés entre le piston (15) et la collerette (12) .

3./ Dispositif selon la revendication 1, caractérisé en ce que le deuxième (4) récipient est une seringue, et l'embout femelle est un cône (4a) "luer lock".

4./ Dispositif selon la revendication 1, caractérisé en ce que le filtre (8) a une porosité assurant une filtration stérile de tout flux gazeux ou liquide le traversant.

5./ Dispositif selon la revendication 1, caractérisé en ce qu'il comporte un capuchon (21) monté sur la collerette (12) pour contenir l'embout femelle (6), agencé pour fermer de manière étanche la partie de la collerette (12) opposée au bouchon (3).

6./ Dispositif selon la revendication 1, caractérisé en ce qu'il comprend des moyens (22) de verrouillage définitif sur le premier récipient (2), bloquant les moyens d'accrochage (13) dans leur position accroché sur le col (2a) du récipient.

7./ Dispositif selon la revendication 1, caractérisé en ce que l'embout femelle (6) comprend un filtre (20) pour la filtration de tout liquide le traversant.

FIG1

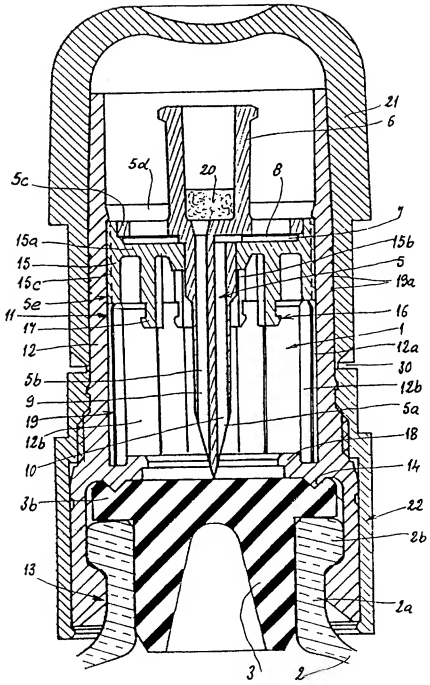

21
6
5d
20
8
5c
7
15a
15b
15
5
15c
19a
5e
16
11
17
1
12
12a
30
5b
12b
9
5a
19
18
12b
14
10
22
3b
26
13
2a
3
2

FIG2

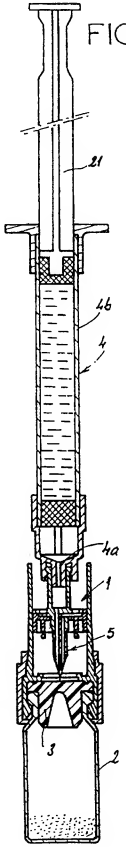


FIG3

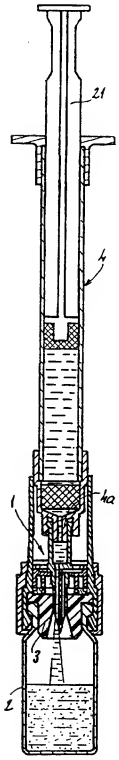
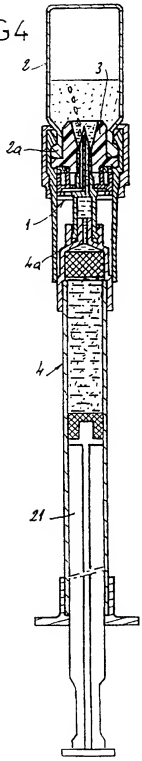


FIG4



US006070623A

United States Patent [19]

Aneas

[11] Patent Number: 6,070,623

[45] Date of Patent: Jun. 6, 2000

[54] **CONNECTING DEVICE, IN PARTICULAR BETWEEN A RECEPTACLE WITH A STOPPER CAPABLE OF BEING PERFORATED AND A SYRINGE**

[75] Inventor: **Antoine Aneas**, Menetrol, France

[73] Assignee: **Biodome, Issoire**, France

[21] Appl. No.: **09/230,798**

[22] PCT Filed: **Sep. 24, 1997**

[86] PCT No.: **PCT/FR97/01676**

§ 371 Date: **Feb. 9, 1999**

§ 102(e) Date: **Feb. 9, 1999**

[87] PCT Pub. No.: **WO98/13006**

PCT Pub. Date: **Apr. 2, 1998**

[30] **Foreign Application Priority Data**

Sep. 25, 1996 [FR] France 96 11965

[51] **Int. Cl.**[7] **B65B 1/04**

[52] **U.S. Cl.** **141/329**; 141/27; 604/200; 604/201; 604/403; 604/406

[58] **Field of Search** 141/25, 27, 319, 141/329, 330, 369, 383; 604/200, 201, 403, 405, 406, 411, 415

[56] **References Cited**

U.S. PATENT DOCUMENTS

3,940,003 2/1976 Larson .
3,977,555 8/1976 Larson .
4,576,211 3/1986 Valentini et al. .
5,636,660 6/1997 Pfleiderer et al. .

FOREIGN PATENT DOCUMENTS

0 126 718 A2 11/1984 European Pat. Off. .
0 679 380 A1 11/1995 European Pat. Off. .
2 256 752 8/1975 France .
2 560 049 A1 8/1985 France .

Primary Examiner—Steven O. Douglas
Assistant Examiner—Timothy L. Maust
Attorney, Agent, or Firm—Oliff & Berridge, PLC

[57] **ABSTRACT**

A connecting device (**1**) between a first receptacle (**2**) and a second receptacle (**4**) comprising a muff joint (**4***a*), the device comprising an apparatus (**5**) for perforating a stopper, including a faucet (**6**) and a filtering chamber (**7**) isolated from outside by a filter (**8**), two independent channels (**9**, **10**) being provided in the perforating apparatus (**5**) for communicating the inside of the first receptacle (**2**) with the faucet (**6**) and the filtering chamber (**7**) respectively, the device further comprising an element (**11**) for displacing with guidance the perforating apparatus (**5**), an element for fastening (**13**) the skirt (**12**) on the neck (**2***a*), a plunger (**15**) mounted in the internal bore (**12***a*) on which the perforating apparatus (**5**) are fixed, for sliding by simple pressure, and an element (**16**) for definitively stopping the plunger (**15**).

7 Claims, 2 Drawing Sheets

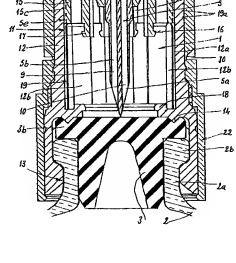


FIG 1

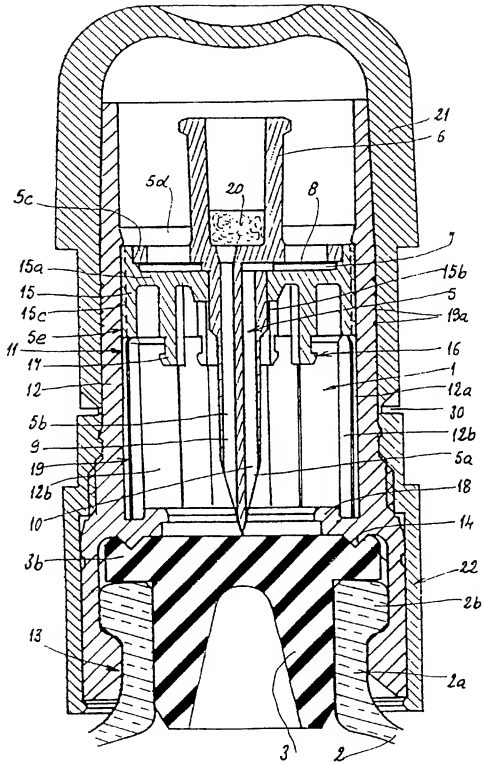

21
6
5d
20
8
5c
7
15a
15b
15
5
15c
13a
5e
11
16
17
1
12
12a
30
5b
12b
9
5a
19
18
12b
10
14
3b
22
2b
13
2a
3
2

FIG2

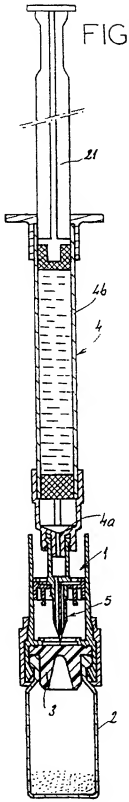


FIG3

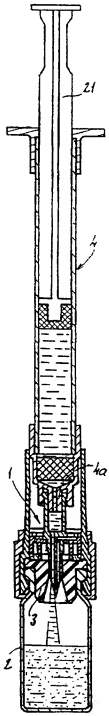
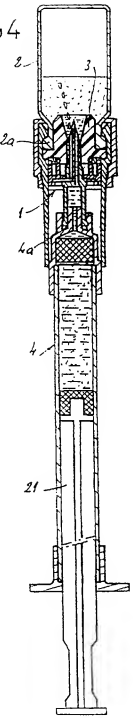


FIG4



CONNECTING DEVICE, IN PARTICULAR BETWEEN A RECEPTACLE WITH A STOPPER CAPABLE OF BEING PERFORATED AND A SYRINGE

FIELD OF THE INVENTION

The present invention generally relates to the connection between, on the one hand, a first receptacle comprising a neck obturated by a visco-elastic stopper capable of being perforated, and, on the other hand, a second receptacle comprising a muff joint (male element).

More particularly, but not exclusively, the present invention will be introduced, defined and described with reference to the connection between, on the one hand, a first receptacle constituted by a rigid flask, for example made of glass, of which the neck is hermetically obturated by a rubber stopper adapted to be perforated, and, on the other hand, a second, likewise rigid receptacle, constituted by a syringe, itself conventionally comprising a rigid tubular body terminating in a muff joint, of the "luer lock" type for example, and a plunger mounted to slide hermetically inside the tubular body. A connection as defined hereinbefore is required in particular when it is question of preparing a medicamentous solution or suspension from an active ingredient in the form of powder or lyophilizate, contained in the first receptacle, namely the flask, and from a liquid medium, for example a solution, contained in the second receptacle, i.e. in the syringe. In such a case, the following operations are generally carried out:

SUMMARY

- the first receptacle (flask) being activated, and the second receptacle (syringe) being filled with the liquid medium, the stopper is perforated with an appropriate perforating means, belonging to the syringe or not, in order to establish a communication between the two receptacles;
- tbe liquid medium of the second receptable (syringe) is introduced inside the first receptacle (flask) in order to mix the liquid medium and the active ingredient in powder or lyophilizate form, the syringe being in that case disposed above the flask,
- the dissolution or suspension inside the first receptacle (flask) being complete, the assembly constituted by the flask and tbe syringe, connected to each other via the perforating means, is turned over in order to dispose the first receptacle above the second receptacle,
- and by pulling the plunger of the syringe, the suspension or solution of the active ingredient is extracted from the first receptacle and introduced in the second receptacle,
- tbe syringe containing the suspension or solution of the active ingredient is then ready to be used, possibly after an injection needle has been positioned on the muff joint of said syringe.

In order to connect two receptacles such as defined and exemplified hereinabove, in accordance with document EP-A-0 126 718, a transfer device with perforation of the stopper has already been proposed, comprising:

- on the one hand, a faucet (female piece) for tight join, for example a cone of the "luer lock" type, for tight join with the muff joint of the second receptacle, and, on the other hand, a filtering chamber isolated with respect to the outside by a filter, for example an absolute filter making it possible to sterilize any gaseous or liquid flow traversing it in one direction or in the other,

- two independent channels provided in said perforating means to establish communication between the inside of the first receptacle and the faucet and the filtering chamber respectively, in the position where the perforating means perforates the stopper, tightly with respect to the outside.

This connection device further comprises means for displacing with guidance the perforating means, constituted at least by a skirt forming an internal bore;

- means for fastening the skirt on the neck of the first receptacle to arrive at a fastened position in which the internal bore opens out on the stopper;
- means for sealing the internal bore with respect to the outside, in the fastened position of the skirt;
- a plunger on which is fixed or to wbich belongs tbe perforating means, this in order to slide by simple pressure, from an inactivated position in which the perforating end is spaced apart from tbe stopper, to a perforating position in which this same perforating end has passed through the stopper.

Such a device allows any non-controlled relative movement between the two receptacles in the course of connection or connected, with the result that it is difficult to master with precision the quantity of liquid medium or liquid, introduced in the first receptacle or extracted therefrom, by means of the relative movement between the plunger and the tubular body of the syringe (second receptacle) for example.

The present invention therefore has for its object a solution making it possible better to control the relative movement between the first receptacle and the second receptacle, when they are connected, so as in particular to minimize and to render constant the dead volume, i.e. liquid whicb cannot be drawn from the first receptacle, after connection of the two receptacles.

In accordance with the present invention, the connection device further comprises:

- means for definitively stopping the plunger in the perforating position, these means comprising a clipping member disposed on or to the side of the plunger, and a complementary stop member disposed on or to the side of the skirt, the clipping member comprising a plurality of teeth distributed around the axis of the plunger, elastic in order to be returned in centrifugal or centripetal manner, the complementary stop member consisting of an annular flank against which said teetb are blocked.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention makes reference to the accompanying drawings, in which:

FIG. 1 shows in transverse section a connection device according to the present invention, in position fastened and locked on a first receptacle, and in tbe inactivated position of the plunger comprising the perforating means; in this Figure, the connection device is also shown with its cap, maintaining seal of the inside of the connection device with respect to the outside.

The representation of FIG. 2 differs from that of FIG. 1 in that the cap has been removed, and the second receptacle is fitted on the perforating means, in the inactivated position thereof.

The representation of FIG. 3 differs from that of FIG. 2 in that the plunger and its perforating means are in the activated, or perforating, position with introduction of the liquid contained in the second receptacle in the first receptacle, in this example by pushing on the plunger of the syringe constituting the second receptacle.

The representation of FIG. 4 differs from that of FIG. 3 in that the assembly of the two connected receptacles is overturned, and the liquid contained in the first receptacle is drawn into the second receptacle, by pulling on the plunger of the syringe for example.

DETAILED DESCRIPTION

In accordance with FIGS. 1 and 2, the connection device described hereinafter makes it possible to connect, tightly with respect to the outside, and in particular by preserving pre-established conditions of sterility:

- on the one hand, a first receptacle 2 for example a glass flask, comprising a neck 2*a* with an annular bead 2*b*, obturated by a stopper 3 made of visco-elastic material (rubber) capable of being perforated and itself comprising a shouldered part 3*b* resting flat on the annular bead 2*b* of the first receptacle; by hypothesis and in use, this flask contains under conditions of tightness (particularly with respect to any outside liquid) and of sterility, a powder or lyophilizate of an active ingredient for example,
- and on the other hand, a second receptacle, comprising a muff joint 4*a*, constituted for example by a conventional syringe, comprising a tubular body 4*b*, a cone of the "luer lock" type, added on one end of the tubular body 4*b*, forming the said muff joint, and a plunger 21 enabling the syringe to be filled or emptied as desired.

The connection device according to the invention proper, making it possible to connect the two receptacles exemplified hereinabove, by perforation of the stopper 3, generally comprises:

- a means 5 for perforating the stopper,
- means 11 for displacing with guidance the said perforating means, constituted at least by a skirt 12 and a plunger 15 on which the perforating means 5 is mounted or to which it belongs,
- means 13 for fastening the skirt 12 on the neck 2*a* of the first receptacle,
- means 14 for sealing the inside of the skirt 12 with respect to the outside, employing the visco-elastic characteristics of the upper part of the stopper 3,
- and means 16 for definitively stopping the plunger 15 in the perforating or perforation position, represented for example in FIGS. 3 and 4.

The perforating means 5 comprises, as shown in FIG. 1, a central or axial part 5*b* terminating in a perforating end 5*a*, a collar 5*c* allowing fixation of the perforating means on the plunger defined hereinafter, in which a circumferential opening 5*d* is made, and a faucet (female element) 6, extending the axial part 5*b*, and ensuring a tight join with the muff joint (male element) 4*a* of the second receptacle (syringe). At the level of the perforating means 5, opposite the perforating end 5*a* hereinafter, a filtering chamber 7 is formed between a bevel shoulder provided in the plunger 15, defined hereinafter, and a filter 8, maintained clamped between the collar 5*c* and a corresponding shoulder provided on the plunger 15, and isolating said chamber with respect to the outside. The faucet 6, disposed on the side opposite the perforating end 5*a*, comprises a filter 20 for filtering any liquid traversing it in one direction or in the other. Two independent channels 9 and 10 are made in the axial part 5*b* of the perforating means 5, to establish communication between the inside of the first receptacle 2 and the faucet 6 and the filtering chamber 7 respectively, in the perforating position shown in FIGS. 2 to 4 for example, in which the perforating means 5 perforates the stopper 4, having traversed it completely by its perforating end 5*a*.

The means 11 for displacing the perforating means 5 with guidance are constituted by the cooperation of the tubular skirt 12, forming an internal bore 12*a*, and of the plunger 15 mounted in the internal bore 12*a*, on which is fixed or mounted the perforating means 5. The skirt 12 is obtained in one piece with the fastening means 13, for example made of plastic material, and as shown in FIG. 1 may extend upwardly, beyond the free end of the faucet 6, in order to prevent an accidental actuation of the plunger by the user's fingers. Furthermore, it is provided with a capsule forming fastening means 13, capable of clipping with respect to and beneath the annular rim 2*b* of the receptacle 2, in contact with the neck 2*a*, and this thanks to a radial elasticity enabling it to return the circumferential lower edge into centripetal position. In practice, this fastening capsule 13 is constituted by a plurality of fastening teeth, together forming the capsule defined hereinabove, and each presenting the radial elasticity mentioned above. In the fastened position shown in FIGS. 1 to 4, the internal bore 12*a* opens out on the stopper 3 and more particularly its upper part accessible to the perforating end 5*a* of the perforating means 5. Means 14 for sealing the internal bore 12*a* with respect to the outside and using the visco-elastic properties of the stopper 3, are likewise constructed in one piece with the skirt 12; these means consist in particular in a continuous, relatively hard, circumferential rib penetrating at least partially in the relatively soft material of the stopper 3.

The plunger 15 comprises a transverse core 15*a* comprising a shouldered orifice 15*b* allowing the passage of the axial part 5*b* of the perforating means 5, with axial hold of said means. As stated hereinbefore, the perforating means 5 is furthermore retained hermetically by its collar 5*c*, on the shoulder defined by the bevel of the filtering chamber 7. By being blocked in rotation with respect to the skirt 12 by the means defined hereinafter, the plunger 15, mounted in the internal bore 12*a*, may slide, by simple axial pressure, from an inactivated position (cf. FIGS. 1 and 2), in which the perforating end 5*a* is spaced apart from the stopper 3, and a perforating position (cf. FIGS. 3 and 4), in which the perforating end 5*a* has completely traversed the stopper 3. The means 19 for blocking in rotation the plunger 15 with respect to the skirt 12 are obtained by making, towards the skirt 12 on its inner surface, eight grooves parallel to the axis of the device, distributed over the periphery of said skirt, and, towards the plunger, eight corresponding ribs (not shown), capable of engaging respectively in the said grooves.

The means 16 for definitively stopping the plunger 15, and consequently the perforating means 5 in the perforating position, in which the perforating end of the means 5 has completely traversed the stopper 3, comprise:

- one or more clipping members 17, belonging to the plunger 15, constituted by teeth distributed about the axis of the plunger 15, which are elastic in order to be returned in centrifugal or centripetal manner; these clipping members 17 together form a ring concentric with the axis of the plunger 15, inside the skirt 15*c* ensuring slide of the plunger in the internal bore 12*a*,
- and one or more complementary stop members 18, disposed on the skirt 12, consisting for example of an annular flank 18, against which or under which the teeth 17 are blocked when the plunger 15 is displaced towards the stopper 3.

The cap 21 is mounted tightly on the skirt 12 in order to contain the faucet 6 and the other internal parts of the device, namely the plunger 15 and the perforating means 5, in isolated manner with respect to the outside, this by hermeti-

cally closing the inner part of the skirt **12**, opposite the stopper **3**. Such seal is obtained in particular thanks to a succession of circumferential plates **19***a* arranged on the outer surface of the skirt **12**, and on which the cap **21** is blocked.

The term "seal" is understood to mean a seal with respect to at least liquids, and enabling in particular conditions of sterility to be maintained inside the connecting device.

Furthermore, the connecting device according to the invention is definitively fixed on the first receptacle **2**. To that end, it integrates means **22** for definitively locking the device on the first receptacle **2**, blocking the fastening means **13** in their position fastened on the neck **2***a* of the receptacle **2**. These locking means consist in particular in an outer ring, constructed in one piece with the cap **21**, but separate therefrom by a line of weakening **30** making it possible to separate the cap from the connecting device.

Functioning of the connecting device **1** according to the present invention is deduced from the representations of FIGS. **2** to **4**, explained by reference to the enumerative of the Figures, and to the second paragraph of the present description.

A device as described hereinabove presents, in addition, different important advantages:

- it is one-use, since, in particular, the means **16** for definitively stopping the plunger **15** exclude another re-use,
- it is completely safe to use, the user at no moment being able to touch the perforating end **5***a* of the perforating means **5** with his/her fingers, since, in particular, the displacement and guidance of the plunger **15** require no intervention other than its being pushed by the muff joint of the syringe.
- the user has no functional need to touch the plunger **15** and/or the perforating means **5** with his/her fingers, and in particular there is no risk of accidental injury.

I claim:

1. Device (**1**) for connection between, on the one hand, a first receptacle (**2**) comprising a neck (**2***a*) obturated by a visco-elastic stopper (**3**) capable of being perforated, and, on the other hand, a second receptacle (**4**) comprising a muff joint (male element) (**4***a*), said device comprising a means (**5**) for perforating the stopper, comprising on the side opposite the perforating end (**5***a*) of said perforating means, on the one hand, a faucet (female element) (**6**) for tight join with the muff joint (**4***a*) of the second receptacle (**4**), and, on the other hand, a filtering chamber (**7**) isolated with respect to the outside by a filter (**8**), two independent channels (**9**, **10**) being made in the perforating means (**5**) for establishing communication between the inside of the first receptacle (**2**) and the faucet (**6**) and the filtering chamber (**7**) respectively, in the position where the perforating means (**5**) perforates the stopper (**3**), said device further comprising means (**11**) for displacing with guidance the perforating means (**5**), constituted at least by a skirt (**12**) making an internal bore (**12***a*), means (**13**) for fastening the skirt (**12**) on the neck (**2***a*) of the first receptacle (**2**) in a fastened position in which the internal bore (**12***a*) opens out on the stopper (**3**), with means (**14**) for sealing the internal bore (**12***a*) with respect to the outside, a plunger (**15**) on which is fixed the perforating means (**5**), to slide by simple pressure from an inactive position in which the perforated end (**5***a*) is spaced apart from the stopper (**3**), and a perforating position in which said perforating end (**5***a*) has traversed the stopper (**3**), characterized in that the device further comprises means (**16**) for definitively stopping the plunger (**15**) in the perforating position, comprising a member (**17**) for clipping on the plunger, and a complementary stop member (**18**) on the skirt, the clipping member comprising

a plurality of teeth (**17**) distributed about the axis of the plunger (**15**), which are elastic in order to be returned centrifugally or centripetally, and the complementary stop member consisting of an annular flank (**18**) against which said teeth (**17**) are blocked.

2. Device according to claim **1**, characterized in that means (**19**) for blocking in rotation are arranged between the plunger (**15**) and the skirt (**12**).

3. Device according to claim **1**, characterized in that the second receptacle (**4**) is a syringe, and the faucet is a "luer lock" cone (**6**).

4. Device according to claim **1**, characterized in that the filter (**8**) has a porosity ensuring a sterile filtration of all gaseous or liquid flow traversing it.

5. Device according to claim **1**, characterized in that it comprises a cap (**21**) mounted on the skirt (**12**) to contain the faucet (**6**), arranged to hermetically close that part of the skirt (**12**) opposite the stopper (**3**).

6. Device according to claim **1**, characterized in that it comprises means (**22**) for definitively locking on the first receptacle (**2**), blocking the fastening means (**13**) in their position fastened on the neck (**2***a*) of the recipient.

7. Device according to claim **1**, characterized in that the faucet (**6**) comprises a filter (**20**) for filtering any liquid traversing it.

* * * * *

APPENDIX C

US 2002/0072706 ("Hiblar")

US 20020072706A1

(19) United States

(12) Patent Application Publication (10) Pub. No.: US 2002/0072706 A1

Hiblar et al. (43) Pub. Date: Jun. 13, 2002

(54) TRANSLUMINAL DRUG DELIVERY CATHETER

(76) Inventors: Thomas Hiblar, Everett, WA (US); Lucas S. Gordon, Sammamish, WA (US)

Correspondence Address:
Ronald M. Anderson
LAW OFFICES OF RONALD M. ANDERSON
Suite 507
600 - 108th Avenue N.E.
Bellevue, WA 98004 (US)

(21) Appl. No.: 09/989,030

(22) Filed: Nov. 21, 2001

Related U.S. Application Data

(63) Non-provisional of provisional application No. 60/254,938, filed on Dec. 11, 2000.

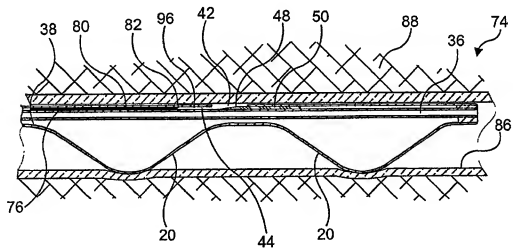
Publication Classification

(51) Int. Cl.[7] A61M 29/00

(52) U.S. Cl. 604/101.01; 604/101.03

(57) ABSTRACT

A catheter for delivering a medical agent to tissue external to a body passage through which the catheter is inserted. The catheter includes a tissue piercing member, e.g., a needle having a rectangular cross-section that is asymmetrically flexible, such that the member is substantially more flexible about a first cross-sectional axis than about a second cross-sectional axis. The tissue piercing member is thus readily deflected about one axis, away from the catheter and into the tissue, while minimizing buckling of the tissue piercing member about the other axis. The catheter can include a balloon located proximal to and on the same side as the piercing member, and a second balloon located distal to and on the opposite side as the piercing member. When inflated, the balloons cause the portion of the catheter between the balloons to flex and bend, facilitating penetration of the tissue by the tissue piercing member.



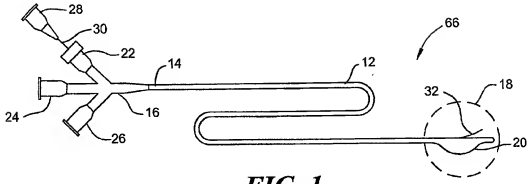


FIG. 1

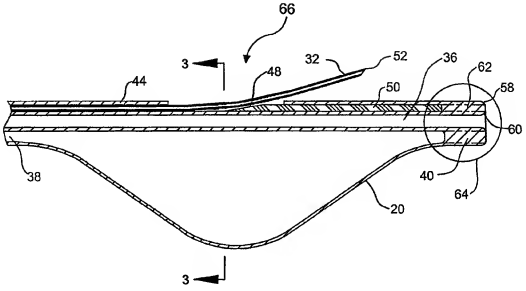


FIG. 2

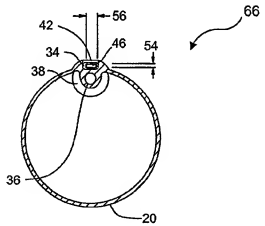


FIG. 3

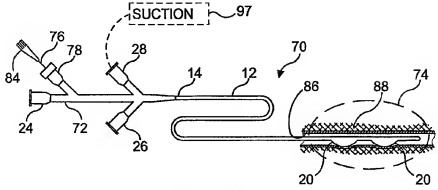


FIG. 4

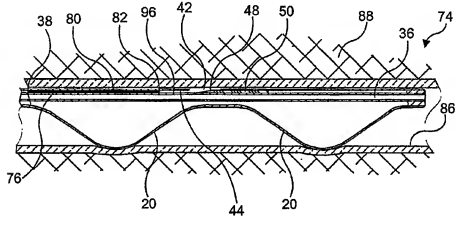


FIG. 5

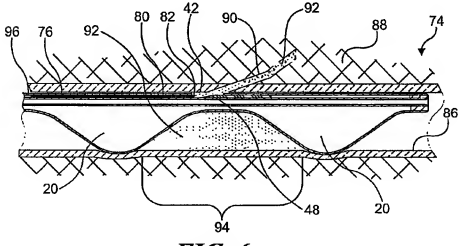


FIG. 6

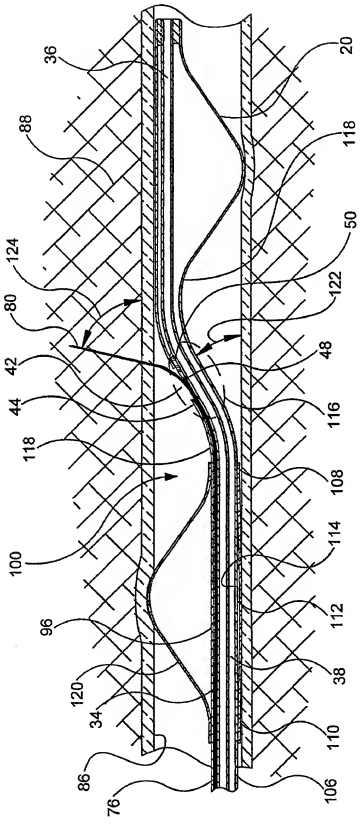

36
88
124
80
42
44
118
100
96
120
34
86
76
20
118
50
122
48
116
108
114
112
38
110
106

FIG. 7

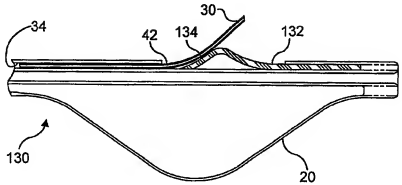


FIG. 8

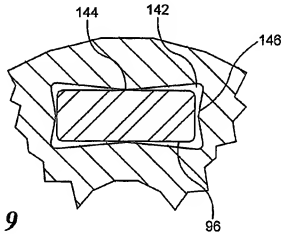


FIG. 9

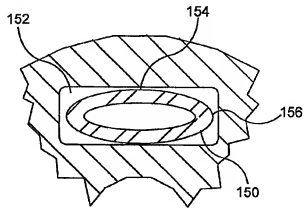


FIG. 10

TRANSLUMINAL DRUG DELIVERY CATHETER

RELATED APPLICATIONS

[0001] This application is based on prior copending provisional application Serial No. 60/254,938, filed on Dec. 11, 2000, the benefit of the filing date of which is hereby claimed under 35 U.S.C. § 119(e).

FIELD OF THE INVENTION

[0002] The present invention is generally directed to the delivery of medical agents through a body passage, and more specifically, to the delivery of therapeutic and diagnostic agents through the wall of a vascular conduit where the agents are too large to diffuse through the walls of adjacent capillary blood vessels into the surrounding interstitial tissue.

BACKGROUND OF THE INVENTION

[0003] It is often necessary to deliver therapeutic and diagnostic agents through the wall of a vascular vessel and into the interstitial tissue of a patient. Such medical agents include antibiotics, chemotherapy agents, proteins, DNA, stem cells, and even conjugated particles or drug delivery vessels such as liposomes. Delivery of low molecular weight medical agents into interstitial tissue is easily accomplished due to the permeability of the capillary and venule blood vessels to small molecules. Typically, such drugs are administered by intravenous injection. The injected drug is carried throughout the body with the patient's blood and passes into all tissues having sufficiently permeable capillary blood vessels. Unfortunately, drugs delivered in this manner may reach many locations in a patient's body where the drug is not desired. Accordingly, it would be desirable to provide a drug delivery system that more specifically targets the portions of the body that should receive the drug being administered.

[0004] The endothelial cells that line the inner walls of most capillary vessels have a spacing of approximately 8 nanometers, allowing molecules smaller than 8 nanometers to pass into the interstitial tissue beyond the wall. This permeability effectively limits drug delivery across the capillary endothelium to smaller molecules having a mass of less than about 10,000 Daltons. Several technologies have been developed to increase the permeability of capillaries, including vasoactive drugs that increase endothelial cell spacing and electroporation, to effectively increase the rate of drug delivery across the endothelium. However, it is still very difficult to deliver large molecules and cellular agents into the vessel wall or into the interstitium beyond, without some type of physical puncturing device.

[0005] Furthermore, in some cases it is desirable to deliver a medical agent into the interstitial space surrounding a vessel that is impermeable to a molecule of any weight. Such vessels include arteries and veins, neither of which allow transfer of an agent into the interstitial tissue surrounding them. Local intramural delivery devices address this problem by contact or penetration of the vessel wall and drug delivery to that site.

[0006] While several catheters have been designed for delivering agents to a vessel, none of them have successfully incorporated all of the following desirable features: simplicity of use, minimal systemic drug delivery, and a simple, reliable mechanical design. For example, one catheter is disclosed by Helzel in U.S. Pat. No. 4,861,336 as a puncture catheter for piercing the vena cava to gain access to the portal vein. This fluid communicating path is then stabilized with a porto-caval shunt. While the catheter described is useful for making this connection, it is neither sufficiently small nor flexible enough to be readily inserted and used in small, and often torturous, arteries and veins.

[0007] U.S. Pat. No. 5,354,279 (Hofling) discloses a catheter for injection of a fluid into body cavities or hollow organs, which includes a plurality of hollow, round needles within the catheter shaft. Retraction of a catheter head causes the needles to project from the catheter head through openings proximate the distal end of the catheter assembly. In one embodiment, a balloon is disposed on the catheter in order to dilate any plaque that may be present within the vessel. Once the needles penetrate into the wall of the cavity, the fluid is injected into the wall. Movement of a plurality of needles through a relatively long intravascular catheter typically would be subject to significant drag between the needles and the catheter shaft. The Hofling design provides a catheter that has low retraction friction forces, since the needles do not slide relative to the catheter shaft. Unfortunately, the Hofling catheter includes many elements, resulting in a catheter that is too stiff and bulky to navigate a torturous path through blood vessels. Additionally, the vessel wall piercing force is generated only by the stiffness of the pre-curved needles, limiting the piercing force that can be applied by the small needles. This problem is significant if the catheter is placed within a vessel that is significantly larger than the catheter diameter, because as the thin needles extend beyond the stabilizing catheter shaft, they experience buckling forces as they attempt to penetrate the vessel wall. This problem is especially pronounced if the vessel is thick and muscular, as is often the case in large arteries. Even if the needle successfully pierces such a vessel wall, it is likely to curve in an unpredictable and undesirable manner, due to the buckling instability of a round needle under the applied longitudinal force.

[0008] This buckling instability is partially addressed by Faxon et al., in U.S. Pat. No. 5,464,395. The Faxon device is a catheter incorporating a lumen passage with a round needle cannula slidably disposed within it. It also includes a lumen for advancing the catheter over a pre-positioned guide wire, as is known in the art. The catheter is advanced over the guide wire within an artery while the needle is in a retracted position within a lumen of the catheter. The tissue piercing tip of the needle is normally curved so that it will exit the distal opening of the catheter lumen at an angle between 30° and 90°. Advancing the needle pushes the curved and sharpened tip outward from the catheter and into the artery wall. However, when in the retracted position, the curve of the needle has a tendency to flex the catheter into that same curve, unless the catheter shaft is stiffer than the needle. Thus, the catheter either is caused by the needle to have a curve at the distal end, making navigation and guide wire tracking more difficult, or the catheter shaft itself is sufficiently stiff to resist the curving force from the needle cannula, which again causes difficulty in navigation and advancement of the catheter along a tortuous path over the guide wire.

[0009] The Faxon catheter includes an asymmetrically disposed balloon that is fixedly and sealably secured to the distal portion of the shaft on the opposite side as the exit orifice provided for the tip of the needle cannula. Inflation of the balloon brings the distal portion of the catheter into direct contact with the artery wall. This configuration reduces the buckling tendency of the needle as it pierces the wall by shortening the distance between the exit orifice in the catheter and the vessel wall. However, because the needle is round, it may still curve in any direction as it extends further from the catheter exit orifice. This problem limits the user's ability to accurately target the needle tip in interstitial tissue at a distance from the vessel puncture location. Additionally, because the balloon does not expand against the entire inner circumference of the vessel, it provides limited stability during needle advancement through the vessel wall.

[0010] The balloon described by Faxon is attached by adhesive or heat bonding, making it very difficult to attach a balloon so as to provide complete, or nearly complete (360°) contact with the vessel wall, if the balloon is proximate to the needle exit orifice. This difficulty is due to the position of the needle exit orifice being located at the balloon to shaft seal. Faxon discloses a configuration wherein a balloon providing full wall contact is positioned distal to the needle cannula. While providing excellent sealing of the balloon to the catheter shaft, this configuration lacks adequate direct support for the needle during its extension into the vessel wall.

[0011] Neither Faxon, nor any of the previously described catheters, address the need to provide torque control or visual guidance of the catheter shaft for precise rotational positioning of the catheter tip. Thus, the methods and devices used in the prior art to deliver medical agents into or beyond the wall of a vessel passage using a catheter advanced needle have several deficiencies relating to flexibility, trackability, torqueability, and the precise targeting of the agent administered to the vessel wall or interstitial tissue.

SUMMARY OF THE INVENTION

[0012] The present invention is directed to a method and apparatus for delivering a medical agent from within a body passage, such as a blood vessel. In accord with the present invention, a medical agent delivery device is defined that can readily be advanced through small and tortuous passages and precisely positioned to deliver a medical agent to a desired location. In general, the delivery device is configured as a catheter that includes an elongated shaft having at least one lumen through which an elongated tissue piercing member is advanced. The tissue piercing member is sufficiently flexible that the catheter is readily advanced through small, tortuous vessels, yet is also sufficiently rigid as to enable penetration into tissue around a vessel.

[0013] Preferably, the tissue piercing member is asymmetrically flexible, such that the member is substantially more flexible about a first cross-sectional axis than it is about a second cross-sectional axis that is substantially different than the first cross-sectional axis. Such a characteristic enables the piercing member to be readily deflected away from a longitudinal axis of the catheter and into tissue outside the vessel, while minimizing any buckling that would tend to inhibit the piercing member from piercing the wall of the vessel or adversely affecting the aim of the piercing member. A piercing member having a rectangular cross-sectional shape can be beneficially employed, as well as other shapes that are not symmetric in all directions. Preferred cross-sectional shapes that provide such flexibility include those having a width along a first orthogonal axis that is substantially greater than a width along a second orthogonal axis.

[0014] An asymmetrically flexible tissue piercing member can also be provided that has a cross-sectional shape that is symmetric relative to two orthogonal cross-sectional axes. For example, a square shaped tissue piercing member can be asymmetrically flexible if adjacent sides are fabricated to have different flexibility. Use of such a tissue piercing member in a catheter provides a device having sufficient flexibility such that it is readily advanced through small vessels, yet which is sufficiently rigid as to enable penetration into tissue adjacent to the vessel.

[0015] Another aspect of the present invention ensures that the distal end of the catheter can be accurately positioned within a body passage. Specifically, the shape of the tissue piercing member relative to a lumen through which the tissue piercing member moves within the catheter ensures that the tissue piercing member cannot freely rotate within the lumen, thereby enhancing a level of control a user has in determining a location at which the tissue piercing member will penetrate a wall of the body passage.

[0016] Still another aspect of the present invention is realized by ensuring that the cross-sectional size and shape of the tissue piercing member and the lumen through which the tissue piercing member moves are selected so that friction between the tissue piercing member and the lumen is reduced and by minimizing the points of contact between the tissue piercing member and the walls of the lumen.

[0017] To ensure that the tissue piercing member is properly positioned for good penetration into the wall of the body passage, an inflatable balloon can be disposed on the catheter opposite an exit orifice in the lumen through which the tissue piercing member passes to reach the wall of the body passage. When inflated, the balloon both stabilizes the catheter within the body passage, and firmly biases the exit orifice of the lumen against the wall of the body passage, ensuring that the tissue piercing member is properly disposed to readily pierce the body passage wall. Another element enhancing penetration of the body passage wall by the tissue piercing member is a ramp that is formed in the lumen of the catheter and disposed adjacent the exit orifice. The ramp deflects the tissue piercing member toward the body passage wall, at an angle closer to perpendicular to the longitudinal axis of the catheter than would be possible without the ramp. The use of such a ramp enables good penetration of the body passage wall to be achieved without requiring that the tissue piercing member be pre-curved, since use of a pre-curved tissue piercing member can make the catheter difficult to advance through tortuous vessels.

[0018] Alternatively, two balloons, respectively disposed distally and proximally to the exit orifice in the lumen, can be employed. When inflated, these balloons isolate a portion of the body passage, so that no medical agent can migrate either proximally or distally, relative to the exit orifice in the lumen through which the tissue piercing member passes. When the tissue piercing member is a solid wire, rather than

a needle that includes its own lumen, the wire is advanced through the exit to create a channel that passes through the body passage wall into tissue beyond. When the wire is removed, a medical agent is introduced via the lumen in the catheter, filling the volume in the body passage isolated between the two balloons and flowing through the channel into tissue beyond the body passage. Also, the two balloons can instead be disposed on opposing sides of the catheter, forcing the catheter to bend, thereby ensuring that the tissue piercing member enters the wall of the body passage at an angle more nearly perpendicular to a longitudinal axis of the body passage than would otherwise be possible. In another embodiment of the present invention, one of the balloons is formed integral to a shaft of the catheter, to minimize the number of joints that could leak.

[0019] A still further aspect of the present invention relates to a method for delivering a medical agent to a desired location within a patient's body, the steps of which are generally consistent with the functions provided by the elements of the apparatus described above.

BRIEF DESCRIPTION OF THE DRAWING FIGURES

[0020] The foregoing aspects and many of the attendant advantages of this invention will become more readily appreciated as the same becomes better understood by reference to the following detailed description, when taken in conjunction with the accompanying drawings, wherein:

[0021] **FIG. 1** is a schematic side view of an embodiment of a catheter system in accord with the present invention, showing a piercing needle in a distally extended position, and a fully inflated distal eccentric balloon;

[0022] **FIG. 2** is an enlarged, cross-sectional view of the distal end of the catheter of **FIG. 1**;

[0023] **FIG. 3** is a cross-sectional view of the distal end of the catheter, taken along section line **3-3** in **FIG. 2**;

[0024] **FIG. 4** is a schematic side view of an embodiment of a catheter system in accord with the present invention that includes two distal eccentric balloons, disposed within a vein;

[0025] **FIG. 5** is an enlarged side view of the distal end of the catheter of **FIG. 4**, showing the balloons inflated and a piercing member in a retracted position;

[0026] **FIG. 6** is an enlarged side view of the distal end of the catheter of **FIG. 5**, showing the balloons inflated and the piercing member in a distally extended position, during drug delivery into tissue surrounding the vein;

[0027] **FIG. 7** is an enlarged, cross-sectional view of the distal end of yet another embodiment of a catheter in accord with the present invention, showing an opposed pair of inflated balloons, and a piercing member in a distally extended position, during drug delivery into tissue surrounding the vein;

[0028] **FIG. 8** is a side view illustration of a distal portion of yet another embodiment of a catheter in accord with the present invention, showing an inflated balloon, a needle in a distally extended position, and an extended ramp that deflects the needle in a desired direction;

[0029] **FIG. 9** is a partial cutaway cross-sectional view of a needle disposed within a lumen of a catheter shaft, the lumen having a shape designed to minimize frictional forces between the needle and the lumen;

[0030] **FIG. 10**, is a similar view of a different embodiment than that shown in **FIG. 9**, wherein a differently shaped lumen and needle that similarly reduce frictional forces between the needle and the lumen are employed;

[0031] **FIG. 11A** (Prior Art) is a cross-sectional view of a piercing member that is symmetrically flexible about any cross-sectional axis; and

[0032] FIGS. **11B-11D** are cross-sectional views of different embodiments of piercing members that exhibit asymmetrical flexibility about different cross-sectional axes, in accord with the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

[0033] Overview

[0034] The present invention is used for delivering a medical agent to tissue external to a body passage, such as a blood vessel, by advancing a catheter to a desired position within the body passage. The catheter includes an elongated tissue piercing member, whose construction or cross-sectional shape provides sufficient flexibility such that it doesn't restrict the catheter from being readily advanced through small, tortuous vessels, yet is sufficiently rigid to enable penetration into tissue outside the body passage. In one embodiment, the shape of the tissue piercing member relative to a lumen through which the tissue piercing member moves within the catheter ensures that the tissue piercing member cannot freely rotate within the lumen, thereby enhancing a level of control that a user has in determining a location where the tissue piercing member will penetrate a wall of the vessel. Further embodiments, as described in detail below, include one or more balloons disposed on the catheter to enhance the ability of the tissue piercing member to penetrate tissue, a lumen having a cross-sectional size and shape to reduce friction with the tissue piercing member, and a ramp provided in the catheter to direct the tissue piercing member outwardly into the wall of the vessel.

[0035] Definition of Terms

[0036] Before explaining how these features are implemented, it will be helpful to define several terms. Note that the definitions provided below are applicable both to this disclosure and to the claims that follow.

[0037] A "catheter" refers to a tubular, flexible instrument that is inserted into a patient's body for withdrawing or introducing fluids, or performing diagnostic or therapeutic procedures, and which is usable within a duct, a blood vessel, a hollow organ, or a body cavity—all of which are encompassed within the term "body passage" as used herein and in the claims.

[0038] A "desired tissue location" refers to a site in a patient's body where a medical agent is to be locally delivered. The desired tissue location may be tissue comprising the inner, middle, or outer wall of a body passage, or tissue external to the wall of the body passage. Once the general desired tissue location has been selected, knowledge of the vascular, lymph, or bile system at that location will

permit the user to select an appropriate access site and a catheter of the proper dimension that can be advanced through a vein, artery, bile duct, lymph duct, or other anatomical body passage in proximity to the desired tissue location.

[0039] The term "medical agent" encompasses therapeutic agents, diagnostic agents, imaging agents, cellular agents, and other agents that are of medicinal value. A medical agent may also comprise conjugated agents, incorporating functional components including carriers (such as microparticles) or encapsulating agents (such as liposomes), therapeutic agents (such as drugs or prodrugs), imaging agents (such as radioactive components), and targeting agents (such as antibodies). Without implying any limitation of the present invention, exemplary examples of carriers and encapsulants include polymer solids, polymer gels, niosomes, and microscopic bubbles.

[0040] The term "therapeutic agent" refers to any drug, chemical or other material that might be infused to an internal treatment site within a patient's body, or used in the treatment of a disease or disorder. Examples, without limitation, include gene therapy agents, antibiotics, chemotherapy agents, anti-neoplastics, hormones, antivirals, radiation (via radiation sources such as cobalt, radium, radioactive sodium iodide, etc.), anticoagulants, enzymes, hepatoprotectants, vasodilators, prodrugs, and the like. A therapeutic agent may also be combined with another liquid such as physiologic saline or the like, and may be administered using the apparatus and methods described herein in accord with the present invention.

[0041] The term "diagnostic agent" refers to any chemical or other material that is used to detect or to determine the nature of a disease or disorder. Exemplary examples of diagnostic agents include, without implying any limitation of the present invention, dyes that react with metabolic products of a particular disease, and radioactive materials that bind to and thereby indicate the presence of disease-causing entities within a patient's body.

[0042] The term "imaging agent" refers to any material comprising an agent that is employed with various types of body scanners to more readily distinguish a specific tissue from surrounding tissues. Examples, without limitation, include radiopaque contrast agents imaged by X-ray systems; ferromagnetic or superparamagnetic metal particles imaged by magnetic resonance; and gas bubbles, low density spheres, and hollow spheres imaged by ultrasound.

[0043] The term "cellular agent" refers to a biological cellular structure, either living or non-living. Examples of cellular agents include viruses, bacteria, autologous, homologous, or interspecies cells such as stem cells, immune cells such as T cells, natural killer cells, B cells, monocytes, lymphokine-activated killer cells, tumor-infiltrating lymphocytes, lymph node lymphocytes, endothelial cells, hepatocytes, antigen-presenting cells, islet cells, and the like.

[0044] The term "asymmetrical flexibility" indicates an element that has different levels of flexibility about different cross-sectional axes. FIG. 11A (described in detail below) illustrates an element exhibiting symmetrical flexibility, while FIGS. 11B-11D (also described in detail below) illustrate examples of elements exhibiting asymmetrical flexibility.

[0045] The term "axially symmetrical" indicates an element that is symmetrical about any cross sectional axis, whereas the term "axially asymmetrical" indicates an element that is symmetrical about less than all cross sectional axes. Both a square and a circle are axially symmetrical, thus both FIGS. 11A and 11D (described in detail below) illustrate shapes exhibiting axial symmetry. FIGS. 11B and 11C (also described in detail below) illustrate examples of shapes exhibiting axial asymmetry.

[0046] The term "about" means that the characteristic modified by such term may vary by zero to 20 percent from the nominal value for that characteristic, and still be within the scope of this invention, unless expressly stated to the contrary.

[0047] Catheter Design Considerations

[0048] A catheter designed for delivery of a medical agent into the wall of a body passage or beyond into a desired tissue location, must meet certain requirements. These requirements include the ability to traverse and navigate through small and torturous body passages or vessels, often at a substantial distance from an initial insertion point into the body. A catheter preferably has sufficient flexibility to follow or track over a thin guide wire that is inserted a patient's body and advanced to a desired location and then used to define the path and form a guiding rail for advancing the catheter to the desired location. Having been advanced to the desired location, the catheter must be manipulated to orient the drug delivery mechanism disposed at the distal end, into the proper orientation relative to the body passage into which the catheter has been inserted. To enable accurate control of the distal end of the catheter, the catheter must be able to accurately transmit torque from the proximal end to the distal end, with repeatability and precision, and with a minimal amount of windup or twisting, as the catheter shaft is rotated. If the catheter shaft experiences windup, it will tend to suddenly release that twist in a rapid, uncontrolled manner (referred to by clinicians as whipping), making it almost impossible to control the final rotational orientation of the distal end of the catheter. These requirements dictate that a suitable catheter possess both longitudinal flexibility and rotational stiffness. If a the drug delivery mechanism includes a needle (or wire) that is used to penetrate the vessel wall, it is also desirable to maintain the correct orientation and stability of the needle as is extends beyond the end of the catheter. If the needle is too stiff, it will adversely affect the tracking of the catheter tip over the guide wire, and if too flexible, it will tend to buckle, so that the wall of the body vessel is not penetrated or so that the aim is deflected to an undesired location.

[0049] Preferred embodiments of the current invention meet all of these requirements by employing several novel elements, including a needle having an asymmetrical flexibility relative to its cross-section, and various means to position the needle tip securely against the vessel wall during penetration. In at least one embodiment, the asymmetrical flexibility is provided by a piercing element whose cross sectional shape is axially asymmetrical, while in at least one additional embodiment, the asymmetrical flexibility is provided by a piercing element whose cross sectional shape is axially symmetrical. The present invention also enables the user to maintain visibility of both the longitudinal and rotational position of the distal end of the catheter

and the needle during use, with a minimum number of additional parts, by combining functions of many of the components of the catheter. Thus, a mechanically robust and simple catheter is achieved. Embodiments of the present invention eliminate joints and bonds found in prior art catheters, to achieve a more robust structure than is typical in prior art catheters used to administer a medical agent to a desired site.

[0050] Exemplary Preferred Embodiments

[0051] Referring to FIGS. 1-3, an exemplary catheter assembly **66** includes an elongated shaft **12**, having a proximal end **14** attached to a fitting **16**, and a distal end **18** that includes an eccentrically disposed inflatable balloon **20**. Fitting **16** has a piercing needle port **22**, a guide wire port **24**, and a balloon inflation luer port **26**. An elongated piercing needle **30** enters catheter **66** through piercing needle port **22**, a distal end **32** of piercing needle **30** exits obliquely from distal end **18** of the catheter, at a location opposite inflatable balloon **20**. A drug infusion luer port **28** is attached at the proximal end of piercing needle **30**, and is in fluid communication with a lumen **46** (FIG. 3) that runs through the length of piercing needle **30**.

[0052] A syringe (not shown) containing a medical agent (such as a therapeutic agent) to be injected into a patient's tissue may be attached to drug infusion luer port **28**. Catheter **66** is of a length sufficient to be introduced into a suitable vessel, such as a femoral vein, and to extend to a desired vein, such as a coronary vein, in proximity to a desired tissue location within a patient. Preferably, catheter **66** is constructed of suitable materials and is of a cross-sectional size that will provide adequate flexibility to negotiate a path through coronary veins that may be curving and torturous.

[0053] Catheter shaft **12** includes a piercing needle lumen **34**, a guide wire lumen **36**, and a balloon inflation lumen **38**, each extending from catheter shaft proximal end **14** to catheter shaft distal end **18**. Guide wire lumen **36** is preferably circular to accommodate a round guide wire (also not shown), while piercing needle lumen **34** is rectangular to accommodate a generally rectangular piercing needle **30**. Piercing needle lumen **34** intersects an orifice **42** in a wall **44** of catheter shaft distal end **18**. Orifice **42** is sized to allow piercing needle distal end **32** to exit obliquely from lumen **34** and is located opposite from balloon **20**. Piercing needle distal end **32** has an angled, sharp tip **52**, to engage and pierce the vessel wall (not shown in these figures) and to facilitate penetration through that vessel wall.

[0054] Balloon inflation lumen **38** is preferably crescent shaped, thereby enabling balloon **20** to be formed integrally with catheter shaft **12**. Balloon catheters typically are fabricated by adhesively or thermally bonding the ends of a separate balloon onto a catheter shaft. If a separate, eccentric balloon were used in this embodiment of the present invention, it would similarly require an additional bond between the balloon and the catheter shaft around orifice **42**. Maintaining such a bond, without leakage, while inflating the balloon, is very difficult. By forming eccentric balloon **20** integrally with shaft **12**, multiple bonds between the balloon and the catheter shaft are eliminated, along with the possibility of leakage from such bonds. Because balloon **20** is integrally formed with catheter shaft **12**, a material must be selected that the requirements for both elements. Suitable materials include polyurethane, cross-linked polyethylene, polyamide, or preferably a polyether block amide such as PEBAX®.

[0055] Piercing needle **30** is slidably disposed in piercing needle lumen **34**, and its distal end **32** is outwardly deflected by an inclined slope **48** on a proximal end of ramp pin **50**, as piercing needle **30** is advanced distally to exit obliquely through orifice **42**. Ramp pin **50** is an elongate element having the same cross-section size and shape as piercing needle lumen **34**, and is preferably secured in position within piercing needle lumen **34** by adhesive bonding, thermal bonding, or other suitable attachment methods.

[0056] It is often necessary to rotationally position the distal end of the catheter in order to advance the piercing needle into the appropriate tissue. This function requires a catheter that has rotational sensitivity and control as well as a marker (such as a fluoroscopic agent) that indicates the rotational position of the distal end, thus enabling the proper orientation of the piercing needle to be achieved. Previous drug delivery catheters have employed substantially round needles or piercing members in substantially round catheter lumens. In such a catheter, rotating the catheter generally does not rotate the round needle, and as the catheter shaft twists during rotation, alignment is not maintained between slope **48** and angled tip **52**. Consequently, there is a strong possibility that jamming will occur when the angled tip is advanced against ramp pin **50**. Preferably, in the present invention, neither the needle nor the catheter shaft (lumen **34**, in which the needle is slidably disposed) are round, but instead, each of these elements have corresponding cross-sectional shapes that prevent a loss of alignment by ensuring that the needle or the catheter cannot rotate independently of each other.

[0057] Note that because ramp pin **50** is fabricated with a rectangular cross-section and contains slope **48**, it can also serve as a rotational fluoroscopic marker if made from a radiopaque material, or plated with such a material. A preferred material for ramp pin **50** is tungsten, because it is both radiopaque and hard, providing an excellent, smooth surface against which angled piercing needle tip **52** can readily slide outwardly from the catheter shaft.

[0058] A rectangular cross-sectional shape has an added benefit for piercing needle **30**, besides preventing loss of alignment. Its relatively thin vertical (as shown in FIG. 3) thickness **54** (i.e., the shorter cross-sectional dimension), enables the needle to easily flex outward when advanced distally, yet the relatively wide horizontal (as shown in FIG. 3) width **56** (i.e., the larger cross-sectional dimension) prevents twisting, buckling, and veering as the needle penetrates the vessel wall, and advances into the interstitial tissue, thus providing more accurate aiming and placement of needle tip **52** in the desired tissue location. A suitable thickness **54** for piercing needle **30** is about 0.007 inches, and a suitable width **56** is about 0.014 inches if the needle is made from a metal such as 304 stainless steel. If constructed from a more flexible material, such as a polymer, these dimensions should be increased in order to maintain the appropriate combination of stiffness and flexibility. Needle **30** is preferably made from a suitable biocompatible, radiopaque metal such as tungsten, gold alloy, platinum alloy or palladium alloy. Other suitable materials include stainless steel or nickel-titanium alloys, incorporating a

gold, platinum, or similar radiopaque coating. While a rectangular cross-section is a preferred shape, it should be noted that a specific shape is not so important, so long as a shape that is selected, regular or irregular, has a cross-section such that its dimension along a first cross-sectional axis is substantially greater than along a second cross-sectional axis that is substantially different than the first cross-sectional axis. The differences in length of such cross-sectional axes ensure that the needle will exhibit different or asymmetrical flexibility about these axes. A cross-sectional shape, such as rectangle or elongated diamond shape, has such unequal length cross-sectional axes. Thus it should be understood that many different cross sectional shapes exhibiting axial asymmetry can be beneficially employed to provide a piercing element expressing such asymmetrical flexibility. It should also be noted, as is described in more detail below, relative to **FIG. 11D**, that cross-sectional shapes that have equal orthogonal cross-sectional axes (such as squares and circles) can also exhibit asymmetrical flexibility, if suitably constructed.

[0059] In certain applications, it may be desirable to reduce the sliding friction between piercing needle **30** and lumen **34**. This reduction in sliding friction may be by coating one or both surfaces with low friction materials such as PTFE, silicone, or polyolefin or hydrogel polymer coatings. Alternatively (or in addition), as will be described in more detail below with respect to **FIGS. 9 and 10**, the cross-sectional shapes of the needle and lumen can be selected so as to further reduce frictional forces between those elements.

[0060] Balloon inflation lumen **38** must be closed at its distal end **40** in order to contain fluid during inflation of balloon **20**. The closure of this lumen may be accomplished by thermally forming a tip **64** on distal catheter shaft **18**. Such tip formation is well known in the art and may be accomplished by a variety of methods, including thermal forming using resistance heated or induction heated dies. During this tip closing operation, distal end **62** of piercing needle lumen **34** may be closed, capturing ramp pin **50**, assuring that it cannot move from its desired position adjacent to orifice **42**. Additionally, radiuses **58** and **60** may be formed on the distal end of the catheter shaft, making tip **64** smooth and atraumatic to passage through a vessel.

[0061] In use, catheter assembly **66** is advanced over a pre-positioned guide wire (not shown) disposed within guide wire lumen **36**, until distal end **18** is disposed at the site of desired drug delivery. In order to provide a very flexible catheter, piercing needle **30** may be partially or fully withdrawn from catheter lumen **34** as the catheter is thus positioned, thereby increasing the flexibility of catheter distal end **18**, providing enhanced tracking of the catheter shaft over the guide wire. Once catheter distal end **18** is properly positioned in the desired vessel location (not shown), piercing needle **30** may be advanced distally through the needle piercing lumen, until angled tip **52** is disposed in catheter distal end **18**. With needle **30** now extended through the full length of lumen **34**, torque applied to fitting **16** is transferred easily to catheter distal end **18**, because needle **30** has a high degree of torsional stiffness, and its non-circular cross-section cannot rotate within non-circular piercing needle lumen **34**. Since ramp **48** is made of radio opaque material, an operator can readily visualize the exact rotational position of distal end **18** using an appropriate imaging system.

[0062] Balloon **20** is next inflated using a pressurized fluid inflator (not shown) attached to balloon inflation port **26**. As balloon **20** is inflated, it urges orifice **42** on catheter distal end **18** firmly against the vessel wall that is opposite the balloon. Piercing needle **30** may then be distally advanced through lumen **34** and up slope **48**, which deflects tip **52** out through orifice **42**, into the vessel wall and beyond, as desired by the operator. A syringe (not shown) containing the desired medical agent may be attached to drug infusion luer port **28**. The syringe (or other fluid delivery device) administers the medical agent through piercing needle lumen **46** and into the desired tissue location. Very little medical agent is lost (i.e., not infused into the desired tissue) during injection because balloon **20** presses catheter orifice **42** firmly against the vessel wall. Balloon **20** may then be deflated and catheter **66** removed or repositioned for administration of the medical agent at a different desired location.

[0063] Although as described this embodiment of the invention includes an axially asymmetrical (e.g., having a rectangular cross-sectional shape) tissue piercing member that extends the full length of the catheter shaft, it should be appreciated that this attribute is only required for that portion of the piercing member that is disposed and advanced from within the distal portion of the catheter shaft. In some cases, it may be desirable to fabricate the tissue piercing element by partially flattening the distal end of a round or square shaft or needle to obtain the desired axial asymmetry, and the corresponding asymmetrical flexibility, in each axis.

[0064] FIGS. **4-6** illustrate another embodiment of the present invention, with **FIG. 4** showing the entire device, and **FIGS. 5 and 6** showing only an enlarged view of the distal end of the catheter, during several steps of delivering a medical agent **92** through the wall of a vein. In these figures, those parts having the same function as in the previous embodiment are designated by the same reference numerals.

[0065] Catheter assembly **70** includes elongated shaft **12** having proximal end **14** attached to a fitting **72** and a distal end **74** having two eccentric inflatable balloons **20**. Fitting **72** includes a piercing wire port **78**, guide wire port **24** and balloon inflation luer port **26**. An elongated piercing wire **76** enters catheter **70** through piercing wire port **78**, and its distal end **80** exits obliquely from catheter distal end **74** at a location between eccentric balloons **20**, and on the opposite side of the catheter shaft. Drug infusion luer port **28** is in fluid communication with a piercing wire lumen **96** of catheter shaft **12** within fitting **72**. Medical agent **92**, to be injected into the patient's tissue, may be administered with a syringe (not shown) when attached to drug infusion luer port **28**. Note that piercing wire **76** is distinguished from piercing needle **30** in that the needle is hollow, while the wire is solid cored. Thus, the wire forms a channel when it is withdrawn, so that a medical agent can be delivered through the channel after the piercing wire is withdrawn, while the needle actually delivers the medical agent before the needle is withdrawn.

[0066] Catheter shaft **12** includes piercing wire lumen **96**, guide wire lumen **36**, and balloon inflation lumen **38**, each

extending from catheter shaft proximal end **14** to catheter shaft distal end **74**. Piercing wire lumen **96** is rectangular in cross-section to accommodate the rectangular cross-sectional piercing wire **76**, which has an angled and sharply pointed distal end **82**. Piercing wire lumen **96** is somewhat larger than piercing wire **76** in both height and width in order to provide area for flow of the desired medical agent **92** during administration through the catheter. Piercing wire lumen **96** extends past orifice **42** in wall **44** of the catheter shaft distal end **74**. Orifice **42** is sized to allow piercing wire distal end **80** to exit from piercing wire lumen **96**. Piercing wire **76** is slidably disposed in piercing wire lumen **96** and its distal end **80** is bent outwardly, so that it exits from orifice **42**, when as the distal end of the piercing wire is advanced distally along inclined slope **48** on the proximal end of ramp pin **50**. The proximal end of piercing wire **76** is attached to a handle **84** to enable an operator to easily manipulate the piercing wire.

[0067] Catheter **70** is shown inserted percutaneously and transluminally into a patient's blood vessel **86** within a tissue **88**. For example, one application of the catheter might be to deliver an angiogenic growth factor such as vascular endothelial growth factor (VEGF) into the myocardium of a patient through a blood vessel, such as the middle cardiac vein. **FIG. 5** shows catheter distal end **74** positioned within vessel **86** and balloons **20** inflated, thus urging orifice **42** against the opposite wall of vessel **86**.

[0068] **FIG. 6** illustrates the delivery of medical agent **92** into tissue **88** after piercing wire distal end **80** has formed a channel **90** and has been withdrawn from the channel. The operator accomplishes this by advancing piercing wire pointed distal end **82** against slope **48** so that distal end **80** is directed outwardly from catheter distal end **74** through orifice **42**, penetrating the wall of vessel **86** and into passing into tissue **88** beyond the vessel wall. After piercing the tissue to the desired depth, distal end **80** of piercing wire **76** is withdrawn back into piercing wire lumen **96**, as shown in **FIG. 6**. The desired medical agent **92** is directed into drug infusion luer port **28**, using a syringe (not shown) or other pressurizing means. Drug infusion luer port **28** (**FIG. 4**) is in fluid communication with piercing wire lumen **96**, allowing medical agent **92** to flow around distal end **80** of piercing wire **76** within lumen **96** and exit through orifice **42** into the channel that the piercing wire created in the tissue. Inflated balloons **20** form a sealed segment **94** within vessel **86**, thus preventing medical agent **92** from escaping from the sealed segment either proximally or distally by flowing through vessel **86**. Medical agent **92** is thus forced into channel **90**. After delivery of the medical agent is complete, balloons **20** are deflated and catheter **70** is removed, or moved to another location for additional drug delivery.

[0069] If it is desired to further limit the amount of medical agent **92** that enters into the patient's vascular circulation, the operator may elect to attach suction means **97** to drug infusion luer port **28**, after the medical agent has been delivered into channel **90**. Suitable suction means include the use of wall suction, or suction available in most hospital settings, generally provided by a centralized facility vacuum system, or individual suction pumps. Syringes or suction bulbs can also be employed. Slow deflation of balloons **20** allows blood to seep into isolated vein segment **94** as excess drug within the segment is evacuated by the suction means. Thus, balloons **20** perform three different functions, including positioning orifice **42** in a desired location within vessel **86**, urging and stabilizing orifice **42** against vessel **86** during piercing wire distal end **80** penetration, and containing medical agent **92** within sealed segment **94** during delivery of the medical agent into channel **90**.

[0070] **FIG. 7** illustrates yet another embodiment of the invention, showing an enlarged, cross-section of a distal end **100** of a transluminal drug delivery catheter, that is disposed within vessel **86**, surrounded by interstitial tissue **88**. This embodiment provides a catheter that can deliver a drug into a channel that is perpendicular or nearly perpendicular to the longitudinal axis of the catheter shaft and of the vessel, through a vessel wall, where the channel was formed by distal end **80** of piercing wire **76**. As with the previous embodiment, two balloons form an isolated sealed segment during drug delivery into the formed channel. This embodiment also provides the same perpendicular (relative to the longitudinal axis of the catheter shaft and vessel) drug delivery to the tissue if a piercing needle (not shown) is used instead of a piercing wire. A catheter shaft **106** also includes piercing wire lumen **96**, guide wire lumen **36**, and balloon inflation lumen **38**. Located on a distal end **100** of the catheter shaft are two inflatable balloons, the more distal being balloon **20**, which is formed integrally with catheter shaft **106**, as previously described, or formed separately and bonded to catheter shaft **106**. A more proximal balloon **120** is formed separately and bonded to catheter shaft **106** by adhesive or thermal bonding, at proximal balloon end **108** and distal balloon end **110**. Balloon **120** is bonded on shaft **106** in a position disposed about 180 degrees around the longitudinal axis of the catheter shaft (i.e., on the opposite side of the catheter shaft from balloon **20**), thus requiring separate fabrication and attachment. Balloons **20** and **120** are inflated with a pressurized fluid delivered through balloon inflation lumen **38**. Pressurization of balloon **120** from inflation lumen **38** is accomplished by an orifice **112** located in a wall **114** of catheter shaft **106**. Inflation of balloons **20** and **120** result in the displacement of catheter shaft **106** against blood vessel **86**, forming the catheter shaft into two reverse bends **118**, and forming the portion of the catheter shaft that is thus bent at an angle **122** relative to the longitudinal axis of the straight portion of catheter shaft segment **116**. Orifice **42** in wall **44** of the catheter shaft is thus positioned approximately midway between balloons **20** and **120** on catheter shaft segment **116**. As in previous embodiments, extending distal end **80** of piercing wire **76** against inclined slope **48** on ramp pin **50** and through orifice **42** results in a very steep piercing angle **124** through the wall of vessel **86**. This steep piercing angle is helpful in precisely delivering drugs in small or complexly disposed anatomical locations.

[0071] **FIG. 8** illustrates yet another preferred embodiment of the invention, showing a distal portion **130** of a transluminal drug delivery catheter that includes eccentric inflatable balloon **20** and rectangular piercing needle **30** disposed within lumen **34**. In this embodiment, ramp pin **132** is bonded within lumen **34**, distal to orifice **42**. Ramp pin **132** is formed from rectangular stainless steel wire with the substantially the same cross-sectional dimensions as lumen **34** and has a bent configuration that forms a curved, inclined slope **134**, facing proximally. By curving the ramp pin in this configuration, the piercing needle may be extended from the catheter at a steeper angle than if just using the sloping end

of the ramp pin to deflect the piercing needle, thereby improving the depth and accuracy of drug delivery into the interstitial tissue.

[0072] FIGS. 9 and 10 illustrate preferred embodiments designed to reduce the sliding friction between the piercing member and the catheter shaft lumen. Although both elements may optionally also be fabricated from or coated with low friction materials, it may be desirable to further reduce the friction by minimizing the surface areas between the piercing member and the lumen that are in contact with each other. FIG. 9 shows a solid rectangular piercing wire 96 within a lumen 142. All four sides of lumen 142 have a convex cross-sectional shape (i.e., are bowed inwardly) to minimize surface contact with wire 96, since the inner surface of the lumen only contacts the piercing wire at points 144 on the long sides and at points 146 on the short sides of the lumen. FIG. 10 shows an oval, hollow piercing needle 150 within a rectangular lumen 152. This combination of lumen and needle shape also effectively limits or reduces contact between the inner surfaces of the lumen and the piercing needle to points 154 on the long sides and points 156 on the short sides of the lumen.

[0073] FIGS. 11A-11D illustrate different cross-sectional shapes of piercing members, and show how flexible the piercing member is along each of two different cross-sectional axes. FIG. 11A shows a prior art piercing member that is equally flexible about two different cross-sectional axes (see arrows). FIG. 11B illustrates a piercing member having a generally rectangular cross-section, which is much more flexible about a first cross-sectional axis (solid line arrows) than it is about a second cross-sectional axis (dash line arrows). FIG. 11C shows a hollow needle having a generally circular cross-sectional lumen and with wings 160 added on opposite sides of the cross-sectional shape to stiffen the piercing member relative to bending about the axis that extends orthogonally to the axis through the wings. Note that the cross sectional shape of FIG. 11C is axially asymmetrical about an axis 161. Finally, FIG. 11D illustrates a generally square shaped cross-section of a piercing member fabricated from a first material 162 on two opposite sides that is significantly more flexible than a second material 164 from which the two other sides are fabricated. Note that the piercing member of FIG. 11D is similarly much more flexible about a first cross-sectional axis (solid line arrows) than it is about a second cross-sectional axis (dash line arrows), even though the dimensions across each of these orthogonal axes are substantially equal. Thus, different dimensions across two cross-sectional axes, while representing one way of providing the required asymmetrical flexibility, are not the only way contemplated to provide the asymmetrical flexibility.

[0074] Although the present invention has been described in connection with the preferred form of practicing it and modifications thereto, those of ordinary skill in the art will understand that many other modifications can be made to the present invention within the scope of the claims that follow. Accordingly, it is not intended that the scope of the invention in any way be limited by the above description, but instead be determined entirely by reference to the claims that follow.

The invention in which an exclusive right is claimed is defined by the following:

1. A tissue piercing catheter comprising:

(a) an elongate catheter shaft, adapted to be inserted into a body passage; and

(b) a tissue piercing member, slidably disposed within said catheter shaft, said tissue piercing member having at least a distal portion that is constructed to be asymmetrically flexible, such that said tissue piercing member is substantially more flexible about a first cross-sectional axis than it is it about a second cross-sectional axis that is substantially different than the first cross-sectional axis.

2. The catheter of claim 1, further comprising:

(a) means to extend the distal portion of said tissue piercing member that is asymmetrically flexible, from the catheter shaft and into a desired tissue location that is external to the catheter shaft, and

(b) means to deliver at least one of a therapeutic agent and a diagnostic agent to the desired tissue location.

3. The catheter of claim 1, wherein said distal portion of said tissue piercing member comprises a sharpened tip.

4. The catheter of claim 1, wherein said tissue piercing member comprises a lumen adapted to deliver at least one of a therapeutic agent and a diagnostic agent into a tissue.

5. The catheter of claim 1, wherein the distal portion of said tissue piercing member that is asymmetrically flexible comprises a composite structure, including a first material and a second material, said first material being substantially more flexible than the second material, and said first and second materials comprising different peripheral portions of said tissue piercing member.

6. The catheter of claim 1, wherein the distal portion of said tissue piercing member that is asymmetrically flexible has a cross-sectional shape such that a dimension of said cross-sectional shape along said first cross-sectional axis is substantially shorter than a dimension of said cross-sectional shape along said second cross-sectional axis.

7. The catheter of claim 1, wherein the distal portion of said tissue piercing member that is asymmetrically flexible has a cross-sectional shape that is axially asymmetrical.

8. The catheter of claim 1, wherein the distal portion of said tissue piercing member that is asymmetrically flexible has a generally rectangular cross-sectional shape.

9. The catheter of claim 1, wherein the distal portion of said tissue piercing member that is asymmetrically flexible has a generally oval cross-sectional shape.

10. The catheter of claim 1, wherein the catheter shaft comprises a lumen in which said tissue piercing member is slidably disposed, an inner surface of said lumen being coated with a material that reduces a sliding friction between the tissue piercing member and the inner surface of said lumen.

11. The catheter of claim 1, wherein the catheter shaft comprises a lumen in which said tissue piercing member is slidably disposed, said lumen having a size and a shape chosen to minimize a frictional contact with said tissue piercing member.

12. The catheter of claim 11, wherein said lumen has a generally rectangular cross-sectional shape, such that at least

one side of the generally rectangular cross-sectional shape is arcuate in shape to reduce a frictional contact with said tissue piercing member.

13. The catheter of claim 1, further comprising an inflatable balloon disposed on a distal end of said catheter shaft, wherein the catheter shaft further includes a balloon lumen adapted to convey a pressurized fluid that is used to inflate said inflatable balloon.

14. The catheter of claim 13, wherein the balloon lumen has a generally crescent shaped cross-section.

15. The catheter of claim 13, wherein the inflatable balloon is formed integrally with the catheter shaft.

16. The catheter of claim 1, wherein the catheter shaft further comprises:

(a) an orifice disposed proximate a distal end of said catheter shaft;

(b) a lumen in which said tissue piercing member is slidably disposed, said lumen being in communication with said orifice; and

(c) a ramp disposed within said lumen adjacent to said orifice, said ramp deflecting said tissue piercing member outwardly from said catheter shaft as said tissue piercing member is distally advanced.

17. The catheter of claim 16, wherein said ramp extends outwardly beyond a perimeter of said catheter shaft.

18. The catheter of claim 16, wherein said ramp comprises a generally elongate member having a cross-sectional size and a shape substantially equal to a cross-sectional size and a shape of said lumen, so that a portion of said elongate member is disposed within the lumen.

19. The catheter of claim 16, wherein said ramp comprises a radiopaque material.

20. The catheter of claim 19, wherein said ramp comprises tungsten.

21. The catheter of claim 16, wherein said ramp comprises a guide channel into which said tissue piercing member is slidably directed as said tissue piercing member is distally advanced.

22. The catheter of claim 16, wherein at least a portion of said ramp is curved to form an inclined plane.

23. The catheter of claim 22, wherein said at least a portion of said ramp that is curved extends outwardly of said lumen through said orifice.

24. The catheter of claim 16, wherein said ramp is disposed flush within said lumen.

25. The catheter of claim 16, further comprising:

(a) an inflatable balloon disposed on the catheter shaft opposite said orifice, such that when the inflatable balloon is inflated, said orifice is forced by the inflatable balloon toward a wall of a body passage into which said catheter is inserted; and

(b) a balloon lumen within said catheter shaft and in fluid communication with the inflatable balloon, said balloon lumen being adapted to convey a fluid used to inflate said inflatable balloon.

26. The catheter of claim 16, further comprising a first inflatable balloon disposed adjacent to and proximal of said orifice, and a second inflatable balloon disposed adjacent to and distal of said orifice, such that when both the first balloon and the second balloon are inflated, a portion of a body passage into which said catheter is inserted, is substantially isolated.

27. The catheter of claim 25, wherein said first inflatable balloon and said second inflatable balloon are disposed opposite said orifice, such that when both the first balloon and the second balloon are inflated, said orifice is forced toward a wall of a body passage into which said catheter is inserted.

28. The catheter of claim 25, wherein said first inflatable balloon is disposed on a same side of said catheter as said orifice and said second inflatable balloon is disposed on an opposite side of said catheter from said orifice, such that when both the first balloon and the second balloon are inflated, said catheter shaft is deflected relative to a longitudinal axis of the catheter shaft, thereby enabling said tissue piercing member to more readily pierce extravascular tissue by directing said tissue piercing member at an angle more nearly perpendicular to the longitudinal axis of the catheter shaft.

29. The catheter of claim 28, wherein an extent by which the catheter is deflected about its cross-sectional axis is sufficient to enable the tissue piercing member to pierce an extravascular tissue at an angle approaching the perpendicular relative to the longitudinal axis of the catheter shaft.

30. A catheter for directly delivering a medical agent into extravascular tissue, comprising:

(a) an elongate catheter shaft, adapted to be inserted into a body passage;

(b) a tissue piercing member, slidably disposed within a lumen formed in said catheter shaft, said tissue piercing member having at least a distal portion that is asymmetrically flexible, such that said tissue piercing member is substantially more flexible about a first cross-sectional axis than it is about a second cross-sectional axis that is substantially different than the first cross-sectional axis;

(c) means for both piercing an extravascular tissue and delivering a medical agent into an extravascular tissue;

(d) an orifice disposed in said lumen, adjacent a distal end of said catheter shaft; and

(e) a ramp disposed within said lumen such that said orifice overlaps at least a portion of said ramp, said ramp comprising a guide channel into which said tissue piercing member is slidably disposed as said tissue piercing member is advanced, thereby deflecting said tissue piercing member outwardly and away from a longitudinal axis of said catheter shaft.

31. A catheter for directly delivering a medical agent into an extravascular tissue, the catheter comprising:

(a) an elongate catheter shaft, adapted to be inserted into a body passage, said elongate catheter shaft including a lumen;

(b) a tissue piercing member, slidably disposed within the lumen in said catheter shaft, said tissue piercing member having at least a distal portion that is asymmetrically flexible, such that said tissue piercing member is substantially more flexible about a first cross-sectional axis than it is it about a substantially different second cross-sectional axis;

(c) means for both piercing extravascular tissue and delivering the medical agent into said extravascular tissue;

(d) an orifice disposed in said lumen, adjacent a distal end of said catheter shaft; and

(e) a ramp disposed within said lumen such that said orifice overlaps at least a portion of said ramp that is formed into an inclined plane, said ramp deflecting said tissue piercing member outwardly, away from a longitudinal axis of said catheter shaft as said tissue piercing member is advanced distally through the lumen, said ramp comprising a generally elongate member having a cross-sectional size and shape generally equal to a cross-sectional size and shape of said lumen.

32. A catheter for directly delivering a medical agent into an extravascular tissue, the catheter comprising:

(a) an elongate catheter shaft, adapted to be inserted into a vascular passage, said elongate catheter shaft including a lumen;

(b) a tissue piercing member, slidably disposed within the lumen of said elongate catheter shaft, said tissue piercing member having at least a distal portion that is asymmetrically flexible, such that said tissue piercing member is substantially more flexible about at least one cross-sectional axis than about other cross-sectional axes;

(c) means for both piercing extravascular tissue and delivering a medical agent into an extravascular tissue;

(d) an orifice disposed in said lumen, adjacent a distal end of said catheter shaft; and

(e) a first inflatable balloon disposed adjacent to and proximal of said orifice on a same side of said catheter as said orifice, and a second inflatable balloon disposed adjacent to and distal of said orifice on an opposite side of said catheter from said orifice, such that when both the first inflatable balloon and the second inflatable balloon are inflated, said catheter is deflected relative to a longitudinal axis of the catheter shaft, thereby enabling said tissue piercing member to more readily pierce an extravascular tissue by moving through the orifice.

33. A catheter for directly delivering a medical agent into an extravascular tissue, the catheter comprising:

(a) an elongate catheter shaft, adapted to be inserted into a vascular passage, said elongate catheter shaft having a lumen formed therein;

(b) a tissue piercing member, slidably disposed within the lumen of said catheter shaft;

(c) means for both piercing extravascular tissue and delivering a medical agent into an extravascular tissue;

(d) an orifice disposed in said lumen, adjacent to a distal end of said catheter shaft; and

(e) a first inflatable balloon disposed adjacent to and proximal of said orifice on a same side of said catheter as said orifice, and a second inflatable balloon disposed adjacent to and distal of said orifice on an opposite side of said catheter from said orifice, such that when the first inflatable balloon and the second inflatable balloon are inflated, said catheter is deflected relative to a longitudinal axis of the catheter shaft, thereby enabling said tissue piercing member to more readily pierce an extravascular tissue when distally advanced through said lumen and out through the orifice.

34. The catheter of claim 33, wherein a distal end of said tissue piercing member comprises a sharpened tip.

35. The catheter of claim 33, wherein said tissue piercing member has a lumen adapted to deliver at least one of a therapeutic agent and a diagnostic agent into an extravascular tissue.

36. The catheter of claim 33, wherein at least a distal portion of said tissue piercing member is asymmetrically flexible, such that said tissue piercing member is substantially more flexible about at least one cross-sectional axis than about other cross-sectional axes.

37. The catheter of claim 36, wherein said distal portion of said tissue piercing member that is asymmetrically flexible comprises a composite structure exhibiting different flexibility at different positions around a longitudinal axis of the composite structure.

38. The catheter of claim 36, wherein said distal portion of said tissue piercing member that is asymmetrically flexible has a cross-sectional shape such that a dimension of said cross-sectional shape along a first cross-sectional axis is substantially less than a dimension of said cross-sectional shape along a second cross-sectional axis that is orthogonal to the first cross-sectional axis.

39. The catheter of claim 36, wherein said distal portion of said tissue piercing member that is asymmetrically flexible has a cross-sectional shape that is axially asymmetrical.

40. The catheter of claim 36, wherein said distal portion of said tissue piercing member that is asymmetrically flexible has one of a generally rectangular cross-sectional shape and a generally oval cross-sectional shape.

41. The catheter of claim 33, wherein the catheter shaft comprises a lumen in which said tissue piercing member is slidably disposed, said lumen being formed so as to reduce frictional contact with said tissue piercing member by having one of a:

(a) a surface coating on an interior surface of the lumen that reduces friction; and

(b) a size and a shape that minimizes frictional contact between the interior surface of the lumen and said tissue piercing member.

42. The catheter of claim 41, wherein said lumen has a generally rectangular cross-sectional shape, and wherein at least one side of the generally rectangular cross-sectional shape is arcuate in shape, to reduce the frictional contact with said tissue piercing member.

43. The catheter of claim 33, further comprising a balloon lumen adapted to convey a pressurized fluid used for inflating said first and second balloons, said balloon lumen having a generally crescent shaped cross-sectional shape.

44. The catheter of claim 33, wherein at least one inflatable balloon is formed integrally with the catheter shaft.

45. The catheter of claim 33, wherein the catheter shaft further comprises a ramp disposed within said lumen such that said orifice overlaps at least a portion of said ramp, said ramp deflecting said tissue piercing member outwardly away from a longitudinal axis of said catheter shaft as said tissue piercing member is advanced distally through the lumen and out through the orifice.

46. The catheter of claim**45**, wherein said ramp extends beyond a perimeter of said catheter shaft.

47. The catheter of claim 45, wherein said ramp comprises a radiopaque material.

48. The catheter of claim 43, wherein said ramp comprises tungsten.

49. The catheter of claim 45, wherein said ramp comprises a guide channel into which said tissue piercing member is slidably disposed as said tissue piercing member is advanced.

50. The catheter of claim 45, wherein said ramp comprises a generally elongate member that is disposed at least partly within said lumen, distal to said orifice, an end of said ramp that is disposed closest to said orifice comprising an inclined plane.

51. The catheter of claim 45, wherein said ramp comprises a generally elongate member that is disposed flush within said lumen, said portion of the ramp comprising an inclined plane.

52. The catheter of claim 45, wherein said ramp comprises a curved portion that extends outwardly of said lumen through said orifice.

53. A catheter for directly delivering a medical agent into an extravascular tissue, comprising:

(a) an elongate catheter shaft, adapted to be inserted into a vascular passage, said elongate catheter shaft including a lumen; and

(b) a tissue piercing member slidably disposed within the lumen of said catheter shaft, a size and shape of both said tissue piercing member and said lumen cooperating so as to prevent said tissue piercing member from rotating within said lumen.

54. A method for accurately positioning a tissue piercing member in a desired portion of an extravascular tissue disposed proximate a body lumen, comprising the steps of:

(a) forming the tissue piercing member such that the tissue piercing member is substantially more flexible about a first cross-sectional axis, and is substantially less flexible about a second cross-sectional axis that is different than the first cross-sectional axis;

(b) including said tissue piercing member in a catheter assembly, such that said tissue piercing member is slidably disposed within said catheter assembly to be advanced through said catheter assembly;

(c) inserting said catheter assembly into the body lumen and advancing the catheter assembly through the body lumen until a distal portion of said catheter assembly is proximate the desired portion of the extravascular tissue; and

(d) advancing the tissue piercing member through the catheter assembly, until said tissue piercing member exits said distal portion of said catheter assembly proximate the desired portion of the extravascular tissue, the substantial flexibility about said first cross-sectional axis enabling said tissue piercing member to be deflected away from said catheter assembly about the first cross-sectional axis and toward said desired portion of the extravascular tissue, while the substantially lesser flexibility about said second cross-sectional axis substantially preventing buckling of said tissue piercing member, enabling the tissue piercing member to accurately penetrate the desired portion of the extravascular tissue.

55. The method of claim 54, wherein the step of advancing the catheter assembly through the body lumen comprises the steps of:

(a) sensing a position of the distal portion of said catheter assembly relative to the desired portion of the extravascular tissue; and

(b) manipulating the catheter assembly within the body passage, relative to the desired portion of the extravascular tissue, until the distal portion of said catheter assembly is disposed adjacent the desired portion of the extravascular tissue;

(c) preventing the independent rotation of the tissue piercing member within the catheter assembly; and

(d) simultaneously rotating the catheter assembly and the tissue piercing member until the tissue piercing member is disposed adjacent to the desired portion of the extravascular tissue.

56. The method of claim 54, wherein the step of advancing the tissue piercing member through the catheter assembly comprises the step of deflecting the tissue piercing member away from a longitudinal axis of said catheter assembly.

57. The method of claim 56, wherein the step of deflecting the tissue piercing member away from the longitudinal axis of said catheter assembly comprises the step of advancing the tissue piercing member along a ramp directing the tissue piercing member away from a longitudinal axis of said catheter assembly and toward the desired portion of extravascular tissue.

58. The method of claim 56, wherein the step of deflecting the tissue piercing member away from the longitudinal axis of said catheter assembly comprises the steps of:

(a) inflating a first balloon disposed adjacent to and proximal of an orifice through which the tissue piercing member extends when advanced, said first balloon being disposed on a same side of the catheter assembly as the orifice;

(b) inflating a second balloon disposed adjacent to and distal of the orifice, said second balloon being disposed on an opposite side of the catheter assembly from said orifice, the inflation of both the first and second balloons causing a portion of said catheter assembly disposed between the first and second balloons to flex and bend; and

(c) advancing the tissue piercing member along a ramp formed in the catheter assembly that directs the tissue piercing member outwardly and away from the flexed portion of said catheter assembly, through the orifice, and toward the desired portion of the extravascular tissue.

59. The method of claim 54, further comprising the step of administering a medicinal fluid into the extravascular tissue through the catheter assembly and a lumen formed in the tissue piercing member, after the tissue piercing member has pierced the extravascular tissue.

60. A method for accurately administering a medical agent to a desired portion of an extravascular tissue disposed proximate a body lumen, comprising the steps of:

(a) inserting a catheter assembly into the body lumen and advancing the catheter assembly through the body

lumen, bringing a distal portion of said catheter assembly to a position that is proximate the desired portion of the extravascular tissue;

(b) inflating a first balloon disposed adjacent to and proximal of an orifice in a wall of the catheter assembly, and on a same side of the catheter assembly as the orifice;

(c) inflating a second balloon disposed adjacent to and distal of the orifice, and on an opposite side of the catheter assembly from said orifice, the inflation of both the first and the second balloons causing a portion of said catheter assembly disposed between the first and second balloons to flex and bend;

(d) advancing a tissue piercing member through a lumen in the catheter assembly until said tissue piercing member exits said distal portion of said catheter assembly through the orifice proximate the desired portion of the extravascular tissue, and pierces the desired portion of the extravascular tissue; and

(e) administering the medical agent to the extravascular tissue through the catheter assembly and through a lumen in the tissue piercing member.

* * * * *

APPENDIX D

US 2003/0093037 ("Parker")

US 20030093037A1

(19) United States

(12) Patent Application Publication (10) Pub. No.: US 2003/0093037 A1

Parker et al. (43) Pub. Date: May 15, 2003

(54) HYPODERMIC SYRINGES

(76) Inventors: David W. Parker, Bury Lancashire (GB); Colin H. Burgess, Ramsbottom Lancashire (GB)

Correspondence Address:
Nixon & Vanderhye
8th Floor
1100 North Glebe Road
Arlington, VA 22201-4714 (US)

(21) Appl. No.: 10/149,756

(22) PCT Filed: Dec. 14, 2000

(86) PCT No.: PCT/GB00/04815

(30) Foreign Application Priority Data

Dec. 14, 1999 (GB) 9929557.8

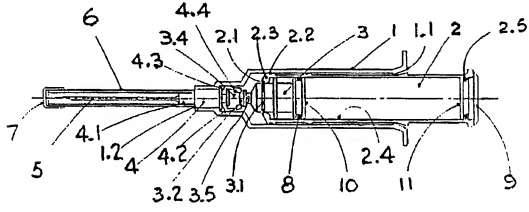
Publication Classification

(51) Int. Cl.[7] A61M 5/315

(52) U.S. Cl. 604/220; 604/192

(57) ABSTRACT

A hypodermic syringe includes a housing (1), a plunger (2) with an associated piston (3), a needle carrier (4) with a needle (5) covered by a removable sheath (6). A vacuum is formed between the plunger (2) and piston (3). When the plunger (2) is operated, the piston (3) engages the needle carrier and a coupling between the plunger and piston is broken, so that the vacuum withdraws the piston (3) into the plunger (2), together with the needle carrier, so as to retract the needle into the housing (1). The needle carrier (4) is rectangular in cross-section and is received in a corresponding rectangular sectioned housing opening (1.2) in order to prevent rotation of the needle carrier relative to the housing. This facilitates removal of the needle sheath, without the risk of a needle stick injury prior to use of the syringe, and allows for the separate and external fitting of a needle.



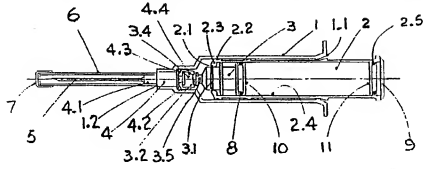


FIG 1

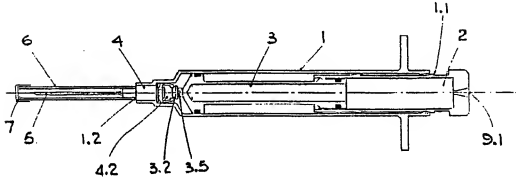


FIG 2

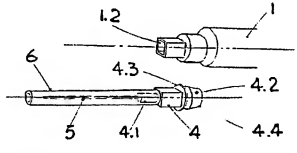


FIG 3

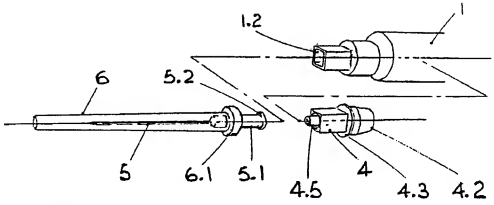


FIG 4 A

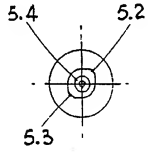


FIG 4 B

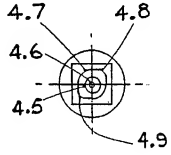


FIG 4 C

FIG 4

HYPODERMIC SYRINGES

FIELD OF THE INVENTION

[0001] This invention relates to hypodermic syringes and particularly to a syringe in which the needle can be withdrawn.

BACKGROUND

[0002] Over recent years, the use of disposable syringes and needles has become increasingly dangerous. Although the risk of accidental scratch or puncture by a used needle, a so-called needle stick injury, has always existed, the increased risk of infection with, for example HIV or hepatitis has become a growing concern to all involved in the provision of health care.

[0003] It is estimated that in the USA, there are approximately 1,000,000 needle stick injuries annually which result in some 20,000 instances of infection with HIV or hepatitis. The consequent cost of these injuries is estimated at US$3 billion per annum. Hypodermic syringes with a retracting needle have been proposed, so that the needle is retracted after use to avoid needle stick injuries. For example U.S. Pat. No. 5,211,628 discloses a hypodermic syringe with a housing, a plunger, a needle carrier with a needle mounted thereto, the needle carrier being mounted on the housing in a housing aperture, with the needle extending outwardly from the housing, and a stored energy configuration, the plunger and the stored energy configuration being arranged so that when the syringe is used and the plunger moves towards the needle carrier, it become attached thereto and the stored energy in the stored energy configuration is released to retract the needle carrier and the needle into the housing through the housing aperture.

[0004] In our co-pending application PCT/GB99/03170 (WO 00/18454) there is described a disposable syringe in which the needle is fitted with a sheath that is attached to the needle carrier. The pre-sheathed needle is fitted into the housing aperture from within the housing thereby reducing the risk of needle injuries. A problem with this arrangement is that when the user wishes to remove the sheath, the needle carrier, which is circular in cross-section rotates within the housing aperture, making it difficult to remove the sheath by the usual twisting action.

[0005] Another problem arises if it is desired to make the needle detachable from the needle carrier. In a conventional syringe, the needle may be attached to the housing by a push fit. If the needle is push fitted to the movable needle carrier, to provide needle interchangeability, there is problem that the stored energy configuration, when withdrawing the needle carrier into the housing, may cause the needle to become detached from the needle carrier. It has been proposed in conventional syringes to securely attach a needle to the syringe using a so-called "Luer lock" which requires rotation of the needle axially relative to its mounting, so as to lock it in position. However, such a locking arrangement cannot be readily used with a retractable needle carrier because rotation of the needle will also produce rotation of the needle carrier relative to the housing making it difficult to secure engagement between them.

SUMMARY OF THE INVENTION

[0006] The present invention provides a solution to this problem. In accordance with the present invention, the housing aperture and the needle carrier are configured so as not to rotate relative to one another about the longitudinal access of the needle.

[0007] Thus, a sheath may be mounted on the needle carrier surrounding the needle, so as to be removable from the carrier utilising an axial rotation of the sheath.

[0008] The needle may be interchangeably mounted and lockable onto the needle carrier by axial rotation of the needle relative to the carrier, for example utilising a Luer lock. Since the needle carrier is constrained from rotation relative to the housing, interchange of the needle on the needle carrier can be readily achieved according to the invention.

[0009] The housing aperture and the needle carrier may be configured so that the needle and sheath can be fitted within the housing.

[0010] Conveniently, the aperture and the co-acting portion of the needle carrier may be non-circular and configured to permit withdrawal of the needle carrier into the housing on release of the stored energy configuration and to prevent relative axial rotation thereof. The co-acting portion of the needle carrier and the aperture may be rectangular in transverse cross-section.

[0011] A piston may be slidably mounted in the housing and releasably coupled to the plunger, the piston being operable when the plunger is moved towards the needle carrier to engage it such that the coupling between the piston and the plunger is released with the result that the stored energy configuration is released so as to retract the needle carried into the housing.

[0012] The stored energy configuration may comprise a vacuum which may be established between the piston and the plunger either internally during assembly of the syringe or by external means after or during assembly of the syringe. Alternative sources of stored energy may be used such as a spring.

[0013] Preferably, the housing aperture is sufficiently large to permit a bent needle to be withdrawn into the housing.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] In order that the invention may be more fully understood embodiments thereof will now be described by way of example with reference to the accompanying drawings in which:

[0015] **FIG. 1** is a schematic cross-section of a first embodiment of the invention;

[0016] **FIG. 2** is a schematic cross-section of a second embodiment of a syringe according to the invention;

[0017] **FIG. 3** is a schematic exploded illustration of the needle carrier and housing aperture in the syringes shown in **FIGS. 1 and 2**;

[0018] **FIG. 4A** is an exploded view of a needle carrier and changeable needle and sheath arrangement according to a modification; and

[0019] **FIGS. 4B and 4C** are end views of the needle and needle carrier respectively.

DETAILED DESCRIPTION

[0020] Referring to FIG. 1, the syringe comprises a generally cylindrical housing 1 that has an open end 1.1 that receives a plunger 2 with an associated piston 3. The housing 1 contains a housing aperture 1.2 which receives the needle carrier 4 on which a needle 5 is mounted such that the longitudinal axis thereof is coaxial with the longitudinal axis of the housing 1 and slidable plunger 2. A sheath 6 with a removable end cap 7 is mounted on a coaxial flange 4.1 on the needle carrier 4.

[0021] In use, the plunger and piston arrangement is operated in a conventional manner to force an injectant through the needle 5 into a patient. Additionally, the syringe is provided with an automatic needle withdrawal mechanism as will now be explained.

[0022] The plunger 2 and piston 3 are assembled so as to create a vacuum in the interior space between them, which provides a stored energy configuration for withdrawing the needle, as will be explained later. To this end, the piston 3 is provided with a triangular sectioned ring 3.1 and the plunger is provided with a sealing surface 2.1 and a plunger head 2.2 which has a radially inwardly facing lip 2.3 that lodges against the triangular sectioned ring 3.1 to provide a releasable coupling. The piston 3 carries a seal 8 which slidably, sealingly engages the inner surface 2.4 of the plunger 2. A closure piece 9 on the plunger 2, is fixedly held in place by a wedge section ring 2.5 on the plunger.

[0023] The needle carrier is formed with a cup 4.2, provided with an abutment lip 4.3, which is fixed onto the main body 4 of the needle carrier, as can be seen clearly in FIG. 3. The cup 4.2 is provided with an annular lip 4.4 for receiving a head 3.2 on the piston. The piston head 3.2 is grooved to provide a by-pass 3.4 and includes a fluid passage 3.5.

[0024] In order to produce a vacuum between the plunger and the piston 3 during assembly, the piston 3 and the closure piece 9 are placed with their surfaces 10, 11 in contact with one another, so as to be held together using an appropriate lubricant. They are then inserted as one piece through the end of the plunger 2 and the closure piece 9 is inserted into groove 2.5. Thereafter, the piston 3 is slid axially along the plunger until the triangular section ring 3.1 snaps past the inward facing lip 2.3, thereby creating and maintaining a vacuum inside the plunger 2 and holding the piston 3 and plunger 2 together as once piece. The plunger closure 9 remains at the end of the plunger 2. The plunger and piston assembly is then ready for insertion into the housing 1.

[0025] However, before inserting the piston and plunger assembly, the assembly of the needle carrier 4, which includes the needle 5 together with sheath 6 and end cap 7, is inserted into the housing, so as to protrude through the housing aperture 1.2, with the abutment 4.3 engaging the interior of the aperture. The aperture 1.2 is sufficiently large to allow the passage of the needle 5, pre-shrouded by the protective sheath 6. The needle sheath and end cap 6, 7 thus affords protection to the needle 5 and also guidance when entering and locating the needle assembly in the housing apertures 1.2.

[0026] Operation of the syringe follows the established practice for disposable syringes. On completion of an injection stroke, automatic needle retraction is triggered by continued pressure on the plunger 2 by the user. Referring to FIG. 1, pressure on the plunger moves the plunger and the piston together as a single piece through the interior of the housing 1 towards the needle carrier 4, thereby expelling the injectant through the needle 5. When the piston 3 meets the end wall of the housing 1, the piston head 3.2 enters the cup 4.2 of the needle carrier 4 and is retained by the lip 4.4. The injectant fluid can then flow along the by-pass 3.4 and the fluid passage 3.5 thereby avoiding a fluid lock. Further inward movement of the piston 3 is now prohibited by the housing 1 and as a result, further inward pressure of the plunger 2 snaps the inward facing lip 2.3 past the triangular section ring 3.1, thereby releasing the piston 3 to slide relative to the plunger 2. As a result, the vacuum within the plunger 2 draws the piston 3 and the needle carrier 4 attached to it, into the plunger 2 thereby withdrawing the needle carrier 4 and the needle 5 automatically.

[0027] The pull exerted by the vacuum on the cup 4.2 during retraction elongates the cup 4.3 axially, thereby reducing its radial pressure against the interior wall of the housing 1 allowing free movement axially inwardly of the housing 1.

[0028] Referring now to FIG. 3, it can be seen that the housing aperture 1.2 and the needle carrier 4 are square in cross-section such that when the needle carrier is received in the housing aperture 1.2 it is prevented from rotating about the axis of the needle 5. Thus, during assembly, when the needle carrier is inserted into the housing aperture 1.2 from within the housing 1, it is locked against rotation. In accordance with the invention, this has the advantage that when the user wishes to remove the sheath 6, this can be done by axially twisting the sheath so to remove it from the mounting region 4.1. Without this feature, the needle carrier would rotate, making it extremely difficult to remove the needle sheath without the risk of a needle stick injury.

[0029] Another embodiment of the invention is shown in FIG. 2 wherein like parts are marked with the same reference numerals used in FIG. 1. In this embodiment, the vacuum produced between the plunger 2 and piston 3 is created by using a vacuum pump or other source of vacuum that is coupled to orifice 9.1 so as to extract air from the interior space between the plunger 2 and piston 3. The orifice is thereafter sealed to maintain the vacuum. The plunger is operated as previously described with reference to FIG. 1 so that when the piston head 3.2 engages the cup shaped member 4.2 on the needle carrier, further depression of the plunger breaks the releasable connection between the plunger 2 and piston 3, with the result that the vacuum withdraws the needle carrier 4 together with the needle 5 axially into the housing 1.

[0030] The structure of the housing aperture 1.2 and the needle carrier 4 is non-circular, as shown in FIG. 3, so as to prevent axial rotation of the needle carrier relative to the housing 1.

[0031] It will be understood that man), modifications and variations fall within the scope of the claimed invention. For example, instead of being rectangular, the needle carrier 4 and housing aperture 1.2 could be of other mutually co-operating non-circular shapes which prevent axial rotation of the needle carrier relative to the housing. It will be understood that the configuration eases the breaking of friction between the needle sheath 6 and the needle carrier 4 when the needle sheath is partially rotated, thus facilitating easier withdrawal of the needle sheath and consequently reducing the risk of damage and/or injury during this process.

[0032] Since the housing aperture 1.2 can be relatively large, the described examples of the invention have the

capacity to retract a bent needle without it jamming against the side walls of the housing.

[0033] A modification to the syringe is shown in FIG. 4, in which the needle is interchangeable. Like parts of those of FIGS. 1-3 are marked with the same reference numbers. Needle 5 is provided with a mounting nipple 5.1 with diametrically opposed end cams 5.2, 5.3. The nipple 5.1 which may be made of plastics material, is provided with an interior axial bore 5.4. The needle carrier 4 includes a central cylindrical spigot 4.5, which includes an axial bore 4.6 through which injectant is supplied to the needle 5. The spigot 4.5 is formed axially within a mounting recess 4.7 to receive the bore 5.4 of the nipple 5.1, the mounting recess including detents 4.8, 4.9 to receive the cams 5.2. 5.3. Thus, the needle can be mounted onto the needle carrier by aligning the cams 5.2, 5.3 with the corresponding detents 4.8, 4.9 and axially inserting the nipple 5.1 into the mounting recess 4.7. Then, by axially rotating the needle so as to axially rotate the cams 5.2, 5.3 and misalign them with the detents 4.8, 4.9, the needle becomes locked into the needle carrier 4. The locking can be released by axially counter-rotating the needle 5 relative to the needle carrier 4 and subsequently withdrawing it in a reverse manner.

[0034] The needle sheath 6 is provided with a peripheral mounting ring 6.1 which may be frictionally engaged or otherwise releasably gripped onto the needle nipple 5.1. Thus, rotation of the needle 5 to lock it in place, can be achieved by gripping the needle sheath 6 and rotating the entire assembly. The needle can be removed in a reverse manner by gripping the sheath. Since the needle carrier 4 is rectangular in cross section and prevented from rotation by the corresponding shape of housing aperture 1.2, mounting and release of the needle from the needle carrier is readily facilitated in accordance with the invention. Furthermore, when the syringe is used, with the sheath removed, and the vacuum between plunger 2 and piston 3 is utilised to withdraw the needle carrier into the housing, the needle 5 is positively locked into the needle carrier 4, thereby minimising the risk of the needle becoming detached as a result of the withdrawal process. Thus, a so-called Luer lock can be provided between the needle and the needle carrier, such that the needle can be rotated to achieve the desired locking action, without corresponding rotation of the needle carrier 4.

[0035] Generally, it will be appreciated that the described embodiments of the invention exhibit the following advantageous features:

[0036] i) reliability and ease of use;

[0037] ii) automatic, complete and immediate retraction of the needle following injection;

[0038] iii) capacity to retract a bent needle;

[0039] iv) re-exposure of the needle is possible;

[0040] v) suitable for production in larger size with an off-set needle;

[0041] vi) supplied with the needle fitted and sheathed;

[0042] vii) suitable for supply pre-charged with an injectant;

[0043] viii) accidental needle retraction before injection is prevented

[0044] ix) low production costs;

[0045] x) firm and compact for safe disposal.

1. A hypodermic syringe including a housing, a plunger, a needle carrier with a needle mounted thereto, the needle carrier being mounted on the housing in a housing aperture with the needle extending outwardly from the housing, and a stored energy configuration, the plunger and the stored energy configuration being arranged so that when the syringe is used and the plunger moves towards the needle carrier, it becomes attached thereto and the stored energy in the stored energy configuration is released to retract the needle carrier and the needle into the housing through the housing aperture, characterised in that the housing aperture and the needle carrier are configured so as not to rotate relative to one another about the longitudinal axis of the needle.

2. A syringe according to claim 1 wherein the needle is receivable onto the needle carrier by axial rotation of the needle relative to the carrier.

3. A syringe according to claim 2 wherein the Luer lock is provided for locking the needle onto the needle carrier.

4. A syringe according to any preceding claim including a sheath mounted to the needle carrier and surrounding the needle, separable from the carrier by axial rotation of the sheath.

5. A syringe according to claim 4 wherein the housing aperture and the needle carrier are configured so that the needle and sheath can be fitted from within the housing.

6. A syringe according to any preceding claim wherein the aperture and a co-acting portion of the needle carrier are non-circular and configured to permit withdrawal of the needle carrier into the housing on release of the stored energy configuration and to prevent relative axial rotation thereof.

7. A syringe according to claim 6 wherein the aperture and a co-acting portion of the needle carrier are rectangular in transverse cross section.

8. A syringe according to any preceding claim including a piston slidably mounted in the housing and releasably coupled to the plunger, the piston being operable when the plunger is moved towards the needle carrier to engage it such that the coupling between the piston and the plunger is released and such that the stored energy configuration is released so as to retract the needle carrier into the housing.

9. A syringe according to claim 8 wherein the stored energy configuration comprises a vacuum established between the piston and the plunger.

10. A syringe according to claim 9 wherein the vacuum has been generated internally during assembly of the syringe.

11. A syringe according to claim 7 wherein the vacuum has been generated by external means during or after assembly of the syringe.

12. A syringe according to any preceding claim wherein the housing aperture is sufficiently large to permit a bent needle to be withdrawn into the housing by the release of the stored energy configuration.

* * * * *

APPENDIX E

WO 99/53886 ("Thibault")

PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : A61J 1/00, B65D 51/00, 41/10 — A1

(11) International Publication Number: **WO 99/53886**

(43) International Publication Date: 28 October 1999 (28.10.99)

(21) International Application Number: PCT/US99/04116

(22) International Filing Date: 25 February 1999 (25.02.99)

(30) Priority Data:
60/082,382 20 April 1998 (20.04.98) US
09/168,502 8 October 1998 (08.10.98) US

(71) Applicant *(for all designated States except US)*: BECTON DICKINSON AND COMPANY [US/US]; 1 Becton Drive, Franklin Lakes, NJ 07417 (US).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: THIBAULT, Jean-Claude [FR/FR]; 18, rue de Cuvilleux, F-38120 Saint Egrève (FR). JANSEN, Hubert [FR/FR]; 17, rue Flora Tristan, F-38320 Poisat (FR).

(74) Agents: SCOTT, Raymond, E. et al.; Howard & Howard Attorneys, P.C., Suite 101, 1400 North Woodward Avenue, Bloomfield Hills, MI 48304 (US).

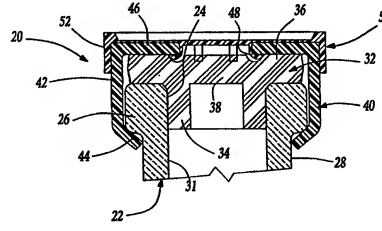
(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published
With international search report.
With amended claims.

(54) Title: PLASTIC CLOSURE FOR VIALS AND OTHER MEDICAL CONTAINERS

(57) Abstract

The plastic closure of this invention is particularly, but not exclusively adapted for sealing medicament vials and other medical containers or as a collar for retaining a fluid transferset on a medical container. The plastic closure of this invention includes a generally tubular portion which surrounds the rim of the container and a free end portion which is permanently radially deformed or crimped into the neck of the container. The plastic closure of this invention is formed of a polymer, preferably a polymeric alloy or melt blend, which is sufficiently malleable to permit radial deformation, yet sufficiently rigid to retain its shape following deformation and sufficiently resistant to creep to maintain the seal between the plastic closure and the container following deformation. A preferred polymer for the plastic closure of this invention is an alloy or melt blend comprising a relatively rigid polymer such as polycarbonate and a soft malleable co-polymer such as a polyester. Where the plastic closure of this invention is used to seal a vial, for example, the closure includes a radial portion overlying the rim portion of the stopper having a central opening and a cup-shaped cap is received over the collar having retainer portions received within the central opening of the cap which may be removed by finger pressure. When the collar of this invention is used to secure a fluid transferset on a vial, the collar includes a proximate tubular portion integral with the radial portion which surrounds at least a portion of the transferset. In one embodiment, the second tubular portion surrounds the entire transferset and the open end is sealed with a peel-off seal and in another embodiment a separate cap surrounds the distal end of the transferset.



FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Paso	GR	Greece			TR	Turkey
BG	Bulgaria	HU	Hungary	ML	Mali	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MN	Mongolia	UA	Ukraine
BR	Brazil	IL	Israel	MR	Mauritania	UG	Uganda
BY	Belarus	IS	Iceland	MW	Malawi	US	United States of America
CA	Canada	IT	Italy	MX	Mexico	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NE	Niger	VN	Viet Nam
CG	Congo	KE	Kenya	NL	Netherlands	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NO	Norway	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	NZ	New Zealand		
CM	Cameroon			PL	Poland		
CN	China	KR	Republic of Korea	PT	Portugal		
CU	Cuba	KZ	Kazakstan	RO	Romania		
CZ	Czech Republic	LC	Saint Lucia	RU	Russian Federation		
DE	Germany	LI	Liechtenstein	SD	Sudan		
DK	Denmark	LK	Sri Lanka	SE	Sweden		
EE	Estonia	LR	Liberia	SG	Singapore		

PLASTIC CLOSURE FOR VIALS AND OTHER MEDICAL CONTAINERS

FIELD OF THE INVENTION

This invention relates to an improved plastic closure such as a cap or collar for closing or sealing containers such as vials containing a medicament which eliminates the problems associated with a malleable metal cap or collar such as aluminum. The plastic closure of this invention may be used as a cap to seal a conventional vial having an elastomeric stopper or as a collar for retaining a fluid transferset separate from or integral with the collar.

BACKGROUND OF THE INVENTION

It is conventional to store medicament such as drugs in a sealed vial or other container for later use. Such medicaments may be in a dry or powdered form to increase the shelf life of the drugs and reduce inventory space. Such dry or powdered drugs are generally stored in a sealed vial and reconstituted in liquid form for administration to a patient by adding a diluent or solvent. Alternatively, the drug may be in liquid or even gaseous form. A conventional vial for storing medicament generally includes an open end, a radial rim portion surrounding the open end and a reduced diameter neck portion adjacent the rim portion. The vial is conventionally sealed with an elastomeric stopper which generally includes a tubular portion inserted into the neck of the vial and a planar rim portion which overlies the vial rim. The stopper is normally secured to the vial with a thin malleable metal cap, such as aluminum. The aluminum cap includes a tubular portion which surrounds the rim portions of the stopper and vial, an inwardly projecting annular portion which overlies the rim portion of the stopper and a distal end portion which is crimped or deformed radially into the vial neck beneath the vial rim portion. Because aluminum is malleable, the collar accommodates the buildup of tolerances of the dimensions of the stopper and vial rim. The dimensions and tolerances of standard vials and stoppers are set by the International Standards Organization (ISO).

The radial portion of the aluminum cap which overlies the stopper rim portion may be closed, in which case the aluminum cap is removed by "peeling" the aluminum cap from the vial. A pre-slit tab located in the middle area is provided which overlies the vial rim, permitting the cap to be torn from the top and peeled from the vial prior to use. This closed embodiment of an aluminum cap has several disadvantages. First, the tearing of the metal cap creates sharp edges which may cut or damage sterile gloves and cut the person administering the drug, thereby exposing both the healthcare worker and the patient to disease and contamination of the drug. Second, the tearing of the aluminum cap generates metal particles which may also contaminate the drug. The dangers associated with the tearing of an aluminum cap has been solved in part by adding a "flip-off" plastic cap. In one such embodiment, the aluminum collar includes a central opening and a shallow plastic cup-shaped cap is received over the aluminum collar having a central projecting riveting portion which is received and secured in the central opening of the aluminum collar. The plastic cap is then removed by forcing the flip-off cap away from the aluminum collar, which tears an annular serrated portion surrounding the central opening and exposes an opening in the collar for receipt of a hypodermic needle or the like. This embodiment reduces but does not eliminate the possibility of tearing the sterile gloves of the healthcare worker. More importantly, however, aluminum dust is still created which may contaminate the medicament. It is also important to note that metallic dust is also created simply by forming and affixing the aluminum collar to the vial because aluminum dust is created in forming the aluminum collar, crimping of the collar and removal of the flip-off plastic cap. Aluminum collars have also been used to secure a fluid transferset on medicament vials. Transfersets may be utilized, for example, to transfer fluid from a syringe to a vial, such as to reconstitute a dry or powdered drug in a vial by adding a diluent or solvent. The reconstituted drug may then be withdrawn from the vial by the syringe. The inner surface of the transferset may be part of the drug fluid path and the aluminum collar or ring may bring aluminum particles in the sterile room where the drug is added to the vial or into the drug fluid path contaminating the drug. There have been attempts to reduce this problem by applying a coating to the aluminum cap or collar. Finally, the prior art

also includes snap-on cup-shaped plastic caps or collars having a radially inwardly projecting end portion which is snapped over the rim portion of the vial. Snap-on plastic collars, however, do not assure adequate sealing of the vial or fully accommodate the tolerances of standard vials and stoppers as required.

The need therefore remains for a closure for vials and other medical containers which may be utilized with conventional containers, such as medicament vials or cartridges, which assures sealing of the container and which achieves a good level of cleanliness, without metal particles or dust which may contaminate the medicament, the transferset or the clean room and which does not expose the healthcare worker to sharp metal edges. The plastic closure of this invention solves these problems and permits the use of the plastic closure of this invention for attaching and sealing containers and fluid transfersets as described below.

SUMMARY OF THE INVENTION

As set forth above, the plastic closure for sealing a vial or other medical container of this invention eliminates the problems associated with a malleable metal or aluminum cap or collar, but which accommodates the buildup of tolerances of the rim portion of the container and the elastomeric stopper, when used. The plastic closure of this invention is relatively inexpensive to manufacture and use. The plastic closure of this invention may be utilized as a cap to seal a conventional medicament vial, as a collar in combination with a flip-off cap or as a collar used to secure and seal a transferset on a vial for transferring fluid between a vial or other container and a second container. As used herein, the term closure is generic to either a cap or collar.

As stated, the plastic closure for sealing a container of this invention may be utilized with a conventional vial having an open end and a reduced diameter neck portion adjacent the open end. The plastic closure of this invention includes a generally tubular portion and a portion which is deformed radially or crimped into the reduced diameter portion of the container to retain the closure on the container and as a cap to seal the open end of the container. The plastic closure of this invention

may also be used as a cap or collar with a conventional vial and elastomeric stopper. In the preferred embodiment, the plastic closure of this invention is formed of a polymer which is sufficiently malleable to permit radial deformation, yet sufficiently rigid to retain its shape following deformation and sufficiently resistant to creep to maintain the seal between the plastic cap and the container following radial deformation.

The preferred embodiment of the plastic closure of this invention is formed of a polymer alloy or melt blend which includes a relatively tough soft malleable co-polymer and a relatively rigid polymer. In the most preferred embodiment of the plastic closure of this invention, the composite polymer is a polymer alloy of a relatively soft malleable co-polymer and a relatively rigid polymer. The preferred relatively rigid polymer is a polyamid or a polycarbonate and the preferred relatively soft co-polymer may be selected from polyesters or polyolefins. The resultant polymer alloy or composite preferably has an elongation at yield between 5% and 10% and an elongation at break greater than 100% with a flectural modulus of greater than 1900 MPa.

Where the container includes a radial rim portion adjacent the open end, the plastic closure of this invention includes a generally cylindrical tubular portion preferably having an internal diameter generally equal to or slightly greater than the external diameter of the rim portion of the container adapted to be received over the rim portion of the container having a free distal end adapted to be deformed radially inwardly or crimped beneath the rim portion of the container and sealed relation. The plastic cap or collar of this invention may also include a radially inwardly projecting proximate portion which overlies the rim portion of the container and/or the stopper. This radial portion may be closed or more preferably includes a central opening which may be closed with a flip-off or peel-off type plastic closure or seal. In the preferred embodiment, the peel-off seal includes a looped end portion which is welded or glued to the tubular portion surrounding the transferset providing indication of tampering and a free end which may be gripped to remove the seal.

Where the plastic collar of this invention is utilized to secure a transferset for transferring fluid from the container to a second container, the preferred embodiment

of the collar includes a second tubular portion which at least partially surrounds the internal components of the transferset. In one preferred embodiment, the second tubular portion completely surrounds the internal components of the transferset, which may have a closed end integral with the second tubular portion or closed with a sealing member. In the most preferred embodiment, the collar portion is integral with the tubular portion surrounding the transferset and the tubular fluid transfer portion such that the major components of the transferset may be molded in one piece. In another embodiment, the transferset includes a cup-shaped cap which is received over the second tubular portion of the collar. In the preferred embodiments of the plastic collar of this invention which secures or is integral with a transferset attached to the container, the internal surface of the tubular portion which surrounds the rim of the container includes an annular resilient ring which is biased against the rim portion of the container to prevent rotation of the collar and transferset on the vial. In one preferred embodiment, the internal surface of this tubular portion includes an annular groove adjacent the free end of the tubular portion and the annular resilient ring is received and retained in the annular groove. The preferred embodiment of the plastic closure of this invention may also be formed of a relatively clear polymer or polymer alloy which maintains its clarity under the stress of deformation which is particularly advantageous where the plastic closure of this invention is utilized as a collar to secure and seal a transferset on the container.

The method of this invention then includes forming a plastic closure having a generally cylindrical tubular portion having an internal diameter generally equal to or slightly greater than an outside diameter of the rim portion of the container and an integral radial rim portion, disposing the closure over the rim of the container with the radial rim portion overlying the rim portion of the vial and the tubular portion surrounding the container rim, and then radially permanently deforming or crimping the free end of the tubular portion of the collar into the neck portion of the container, beneath the rim portion, permanently securing the closure on the container and sealing the container open end. In the most preferred embodiment of the method of this invention, the plastic closure of this invention is formed by injection molding the plastic closure from a polymeric alloy or composite having a relatively soft malleable

polymer or co-polymer and a relatively rigid polymer, wherein a polymeric alloy or composite is formed during the injection molding. Where a resilient or polymeric ring is utilized to prevent rotation of the closure on the container, the ring may be co-injected with the polymer forming the closure or an annular groove may be formed in the tubular portion of the closure, adjacent the free end. The method then includes inserting the annular resilient ring in the groove prior to radial permanent deformation of the free end of the closure as described, such that the resilient ring is biased against the rim portion of the container. A thermoplastic elastomer may also be co-injected with the polymer forming the closure to form a coating or film on the inside surface of the closure which is integrally bonded to the polymer of the cap.

The plastic closure of this invention may be utilized with a vial or other medical container having a conventional elastomeric stopper or as a collar in combination with a transferset having a sealing member as disclosed in the prior art or more preferably the collar portion may be formed integral with components of the transferset. Where the plastic closure of this invention is used to seal a container having an elastomeric stopper, the proximate radial lip of the closure is received over and preferably biased against the resilient radial lip of the stopper during radial deformation or crimping of the free of the tubular portion of the closure beneath the rim of the container. The plastic closure of this invention thus eliminates the problems associated with malleable metal collars or caps, such as aluminum, and is relatively inexpensive, and simple to manufacture, particularly when compared with aluminum caps having a protective coating. The plastic closure of this invention assures an excellent seal of the container and can be injection molded in a clean environment or washed, if necessary. Finally, the plastic closure of this invention accommodates the tolerances of the vial and particularly the buildup of tolerance variations in the combination of a conventional vial and elastomeric stopper. Other advantages and meritorious features of the present invention will be more fully understood from the following description of the preferred embodiments, the appended claims and the drawings, a brief description of which follows.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a side cross-sectional view of one preferred embodiment of the plastic closure of this invention secured to and sealing a conventional vial having an elastomeric stopper;

Figure 2 is an exploded side cross-sectional view of the open end of a conventional vial, elastomeric stopper and the plastic closure shown in Figure 1 prior to radial deformation of the free end of the closure;

Figure 3 is a side partially cross-sectioned view of the assembly shown in Figure 1 illustrating radial deformation or crimping of the closure;

Figure 4 is a partial side view of an alternative embodiment of the plastic closure of this invention assembled on a vial or other container;

Figure 5 is a top cross-sectional view of Figure 4 in the direction of view-arrows 5-5;

Figure 6 is a side view of a vial and transferset assembly having the plastic collar of this invention;

Figure 7 is a partial side cross-sectional view of an alternative embodiment of the vial and transferset assembly;

Figure 8 is a partial side cross-sectional view of the vial, collar and transferset assembly similar to Figure 7 of an alternative embodiment of this invention;

Figure 9 is a partial side cross-sectional view of a vial, stopper and transferset assembly of this invention;

Figure 10 is a partial side cross-sectional view illustrating a further alternative embodiment of the vial and transferset assembly of this invention;

Figure 11 is a side cross-sectional view of an embodiment of a collar and transferset assembly similar to Figure 9 which has been simplified to reduce costs; and

Figure 12 is top perspective view of the transferset shown in Figure 11 illustrating a preferred embodiment of the peel-off seal.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Figures 1 to 3 illustrate one preferred embodiment of the vial, stopper and cap assembly 20 of this invention. As set forth above, the closure of this invention may be utilized to seal various containers and is particularly useful for sealing medicament containers such as the conventional vial 22 illustrated in Figures 1 to 3. The vial includes an open end 24, an annular radially extending rim portion 26 and a neck portion 28 adjacent the rim portion. As best shown in Figures 9 and 10, the neck portion 28 of the vial has a reduced diameter when compared to the rim portion 26 and the container portion 30. The internal surface 31 of the vial adjacent the open end 24 is generally cylindrical. Medicament vials of this type are generally formed of glass or a sterilizable plastic. The open end 24 of the vial is typically closed with an elastomeric stopper 32 having a tubular body portion 34 which is received in the open end 24 of the vial and a planar rim portion 36 which overlies the rim portion 26 of the vial as shown in Figure 1. The stopper is generally formed of a resilient elastomeric material such as synthetic or natural rubber. The central portion 38 of the planar rim portion 36 may be pierced with a hypodermic needle, for example, to either withdraw fluid from the vial or add a solvent or diluent to the vial where the medicament in the vial is a dry or powder drug. The tubular portion 34 of the stopper has an external diameter generally greater than the internal diameter of the internal cylindrical surface 31 of the vial to provide a tight or interference fit.

One preferred embodiment of the closure 40 is shown in Figure 1 attached to a vial 22 and stopper 32 assembly, prior to assembly in Figure 2 and during assembly in Figure 3. This embodiment of the collar 40 includes a tubular portion 42 which surrounds the rim portion 26 of the vial and the planar rim portion 36 of the stopper. Where the external surface of the rim portion 26 of the vial is cylindrical, the tubular portion 42 of the collar will generally also be cylindrical. As shown in Figure 1, the free end 44 of the tubular portion 42 is deformed inwardly or crimped beneath the adjacent surface of the rim portion 26 of the vial, permanently securing the collar 40 on the vial and sealing the vial. This embodiment of the collar 40 also includes an integral radial proximate portion 46 which overlies the rim portions 26 and 36 of the

vial and stopper, respectively. The radial portion 46 is preferably integral with the tubular portion 42 of the collar. This embodiment of the collar 40 also includes a central opening 48 which overlies the central portion 38 of the stopper, preferably coaxially aligned with the central portion of the stopper. As described below, however, the central opening 48 may be eliminated in certain applications of this invention. As used herein, the terms proximate and distal are used solely for ease of description, wherein the term proximate refers to elements or portions of elements closest to the rim portion 36 of the stopper and distal refers to elements or portions of elements more remote from the rim portion of the stopper. Further, the terms cap and collar are sometimes used herein interchangeably. The term cap, however, generally refers to a closure having a radial portion which overlies the container opening and collar is used to refer to a closure used to secure an element, such as a transferset, to the container.

In this disclosed embodiment, the collar 40 includes a shallow cup-shaped cap 50. In the disclosed embodiment, the cap 50 includes a tubular portion 52 which surrounds the proximate portion of the tubular portion 42 of the collar, an integral central radial bridging portion 54 and a plurality of U-shaped tabs which, in the disclosed embodiment, are integral with the central bridging portion 54. The U-shaped tabs 56 are received through the central opening 48 of the collar and snap in place to securely retain the cap 50 on the collar 40. As shown in Figure 2, the cap 50 may be preassembled on the collar 40 prior to assembly of the collar on the vial. The tabs 56 may also be separate members or the central portion of the cap 50 including the tabs 56 may be a separate member.

The collar 40 is then assembled on the vial 22 as shown in Figure 2. In a typical application, the tubular portion 34 of the stopper is first inserted into the opening 24 of the vial 22 generally after the vial is filled. As set forth above, the plastic collar 40 of this invention may be used with various containers including conventional medicament vials as shown. Thus, in a typical application, the vial 22 will first be filled with a medicament. The tubular portion 42 of the collar 40 is then received over the rim portion 36 of the stopper and the rim portion 26 of the vial as shown in Figure 3. The free end 44 (shown before deformation in phantom in Figure

3) is then deformed radially beneath the radial rim 26 of the vial by a suitable tool, such as the crimping tool 58 shown in Figure 3. The disclosed embodiment of the crimping tool includes a conical rim 60 which deforms or crimps the free end 44 of the collar beneath the rim 26 of the vial. In a typical application, the tool 58 is rotated around the rim 26 of the collar 40, deforming or crimping the free end 44 as shown in Figures 1 and 3. In certain applications, it may be desirable to heat either the free end 44 of the collar or the tool 58 to facilitate crimping. The sealed vial may now be stored for later use.

When the vial is ready for use, the cap 50 may be removed simply by forcing one side of the cap 50 upwardly away from the collar 40, removing the cap 50 from the collar 40 and exposing the central opening 48 of the collar and the central portion 38 of the stopper. The central portion 38 of the stopper may then be pierced with a conventional hypodermic needle, for example, providing access to the container portion 30 of the vial. Where the material of the cap 50 is selected to provide resiliency, such as polyethylene or polypropylene, the tabs 56 will bend under thumb pressure, permitting easy removal of the closure 50. Alternatively, where the material of the cap is relatively rigid, at least some of the tabs 56 will break also permitting removal of the cap. It should also be noted that the radial portion 46 of the collar is preferably compressed against the resilient rim portion 32 of the elastomeric stopper during radial deformation of the free end 44 of the collar to assure a secure seal of the vial following installation. The tabs 56 are thus compressed into the radial rim 32 of the stopper as shown in Figure 1.

The polymer selected for the plastic closure of this invention can best be described by its required physical properties. The polymer must be sufficiently malleable to permit radial deformation or crimping, yet sufficiently rigid to retain its shape following deformation. The polymer must also be sufficiently resistant to creep to maintain the seal between the plastic cap and the container following radial deformation. It has been found that a polymer having an elongation at yield between 5% and 10% and an elongation at break greater than 100%, combined with a flexural modulus of greater than 1,900 MPa has superior performance. Where the plastic closure of this invention is utilized for sealing vials containing a medicament, the

polymer should also be sterilizable and, in certain applications such as the plastic collar for a vial transferset described below, the polymer is preferably relatively clear and maintains its clarity under the stress of deformation or crimping. It has been found that certain polymer alloys or composite polymers including melt blends or alloys and co-polymers having polymers of different malleability and rigidity are preferred in many applications. That is, the plastic closure of this invention is preferably formed of a polymer alloy, composite polymer or co-polymer including a relatively rigid polymer and a tough relatively soft malleable co-polymer. The most preferred polymer is a polymer alloy or melt blend including a polyamid or polycarbonate as the rigid polymer providing the strength and resistance to creep desired for this application. The relatively soft malleable co-polymer may be selected from various polymers including polyesters and polyolefins; however, a polymer alloy including a polycarbonate or polyamid and a polyester has been found particularly suitable for this application.

As will be understood, various polymeric melt blends, alloys, composites and co-polymers are being developed on a rapidly increasing basis and therefore the plastic collar of this invention is not limited to a specific polymer, provided the polymer has the desired physical properties described above. Suitable polymers for the plastic collar of this invention include EASTAR® MB polymers, which are melt blend and alloy polymers and EASTAR® thermoplastic polymers, which are neat polymers sold by Eastman Chemical Company of Kingsport, Tennessee and Eastman Chemical AG of Zug, Switzerland under the trade names "DA003, DN003" and "DN004". These materials are polymer melt blends, alloys and co-polymers of polycarbonate or polyamid and polyester. As used herein, the terms melt blends and alloys refer to polymeric compositions having two or more polymers of different physical properties or characteristics, such as the EASTAR® polymers of Eastman Chemical Company described above which include a polycarbonate or polyamid and a polyester. The polymer selected for the plastic collar of this invention may also include fillers and other constituents which would be more accurately described as a composite. Although the base polymers may still be a polymeric melt blend or alloy. As used herein, the term composite is used in its broadest sense to include alloys or

melt blends, composites and co-polymers. As will be understood, the manufacturer or supplier of the raw material will normally blend the polymers based upon the specifications of the customer. The polymers may be co-injected to form a polymeric melt blend, alloy or composite or formed by any other suitable processes. It is anticipated, however, that other polymers having the described physical characteristics may also be utilized in the plastic collar or cap of this invention. In certain applications, it may also be desirable to coat at least the interior surface 43 of the collar shown in Figure 2 with a thermoplastic elastomer, or the entire collar may have a thin layer of a thermoplastic elastomer. The thermoplastic elastomer coating may be applied as a film or by co-injection with the polymer forming the collar 40. The collar 40 and the closure 50 may be formed by conventional injection molding processes.

The plastic collar 140 of the vial, stopper and collar assembly 120 shown in Figures 4 and 5 may be identical to the collar 40 shown in Figures 1 to 3 except that the collar 140 includes a plurality of ribs 162 which provide an improved finger gripping surface for removal of the cap or closure 50. The vial 22, elastomeric stopper 32 and the cap or closure 50 are identical to the same elements in Figures 1 to 3 and are therefore numbered the same. The collar 140 is numbered in the same numerical sequence as the collar 40 in Figures 1 to 3 for ease of reference. As described above, the cap or closure 50 may be eliminated in certain applications in either embodiment by either providing an integral frangible central portion or by applying a peel-off seal of paper, plastic, aluminum or foil over the radial portion 46 adjacent the central opening 48 having a suitable adhesive providing a microbio barrier sealing the central opening 48.

Figure 6 illustrates one embodiment of the plastic collar or cap 240 of this invention mounted on a conventional vial 22 having a container portion 30 utilized to secure a fluid transferset 250. The plastic collar 240 of this invention may be utilized to secure any fluid transferset to a suitable container, such as the conventional vial 22 shown in Figure 6 including but not limited to the fluid transferset disclosed in co-pending application Serial No. 09/031,302 filed February 26, 1998, the disclosure of which is incorporated herein by reference. The plastic collar 240 of this invention

includes a tubular portion 242 and a free distal end 244 which is deformed radially or crimped beneath the rim portion 26 of the vial 22 as described above and shown in Figures 7 and 8. In the embodiment of the vial and transferset assembly 220 shown in Figure 6, the collar includes a radial portion 246 and a second tubular portion 248 integral with the radial portion 246 having a diameter less than the tubular portion 242. In this embodiment, the fluid transferset 250 includes a cup-shaped cap or closure 252 having a proximate radial portion 250 as shown in Figures 7 and 8 which is received between the radial portion 246 of the collar which overlies the rim portions of the elastomeric stopper and the vial secured in place by the plastic collar 240.

Figures 7 and 8 illustrate alternative embodiments of the collar assembly shown in Figure 6 which include an elastomeric or rubber element limiting rotation of the collar on the vial. In the embodiment of the collar 240 shown in Figure 7, the distal free end 244 of the tubular portion 242 includes a groove 264 in the internal surface 243 which receives a rubber or an elastomeric O-ring 268. Thus, when the free end 244 is deformed radially inwardly or crimped against the underside of the rim portion 26 of the vial, the O-ring 268 is resiliently deformed against the rim portion 26 providing torque resistance to turning of the collar 240 relative to the vial. In one embodiment of the fluid transferset, the cap 252 is removed prior to use by twisting the cap which is provided with a frangible portion 270 formed by the V-shaped groove 272 located beneath the tubular portion 248. The frangible connection between the distal portion of the cup-shaped cap 248 and the proximate portion including the radial flange 252 may take various forms, including, for example, a V-shaped continuous or discontinuous groove in the inner or outer wall of the cap. Thus, it is desirable to increase the torque required to turn the collar 240 relative to the vial which is provided by the O-ring 268. In addition, the O-ring provides an additional seal preventing contamination of the space between the collar and the vial. Thus, the O-ring 268 or the seal disclosed in Figure 8 may be added to the embodiments of the plastic collar shown in Figures 1 and 4. In the embodiment of the collar assembly 340 shown in Figure 8, the O-ring has been replaced with an annular sealing member 368 which, in the disclosed embodiment, is flat or generally

rectangular. The annular sealing member 368 shown in Figure 8 may be formed of a suitable elastomeric material, such as natural or synthetic rubber, which is co-injected with the polymer forming the collar 240 or 340 or secured to the internal surface 243 or 343 of the free end 244 or 344 of the tubular portion of the collar by a suitable adhesive. The common elements of the vial, stopper and transferset shown in Figures 6, 7 and 8 are numbered the same and the collar 240 and 340 are numbered in the same numerical sequence for ease of reference.

Figures 9 and 10 illustrate alternative embodiments of the plastic collar of this invention utilized to secure a vial transferset as described more fully in the above-referenced co-pending patent application, wherein the plastic collar forms a part or component of the transferset. Again, the vial 22 may be identical to the medicament vial described above or other suitable container. The elastomeric stopper 32 may be identical to the elastomeric stopper described above except that in this embodiment, the tubular portion 34 of the stopper includes conventional axial slots 35 which permit freeze drying of liquid in the vial 22.

The components of the vial fluid transferset disclosed in the above-referenced patent application need not be described herein in detail. Briefly, the fluid transfer assembly or transferset 462 includes a tubular transfer member 464 and a piercing member 466. The tubular transfer member 464 includes a Luer connection 468 which in the disclosed embodiment are male threads on the exterior surface of the tubular transfer member. The piercing member 466 includes a pointed piercing end 470 and an external channel 472 which, in the disclosed embodiment, extends from adjacent the piercing end 470 to the body or barrel portion 473. The external channel 472 may be continuous and extend longitudinally as shown or extend spirally or be discontinuous. The tubular transfer member 464 includes a proximate internal surface 474 and a distal internal surface 475 having a diameter less than the internal diameter of the proximate internal surface 474 to define a lip 476 which receives the radial flange 478 of the piercing member 466, such that the piercing member 466 is retained in the tubular transfer member 466 for telescopic movement of the piercing member toward the central portion 38 of the elastomeric stopper 32. The proximate end of the tubular transfer member 464 in the disclosed embodiment includes a relatively

sharp edge 480 which is pressed into the central portion 38 of the elastomeric stopper during assembly as described below and includes an integral outer tubular portion 482 having a radial lip 484 which includes an annular barb 486 which is pressed into the radial rim portion 36 of the stopper.

The plastic collar 440 of this embodiment of the invention includes a tubular portion 442 which surrounds the planar rim portion 36 of the stopper and the radial rim 26 of the vial. In this embodiment, however, the internal surface of the tubular portion 442 has a plurality of longitudinal ribs 443 which engage the planar portion 36 of the stopper and the rim 26 of the container and retains the collar on the container following preassembly. In the disclosed embodiment, the collar includes three ribs 443 spaced equally along the tubular portion 442; however, the number may be varied as desired. The free end 444 is deformed radially inwardly or crimped around the rim portion 26 of the vial as described above which includes an elastomeric O-ring 488 which limits rotation of the collar 440 on the vial 22. The collar 440 further includes a radial portion 490 integral with the tubular portion 442 which overlies the rim portions 36 and 26 of the elastomeric stopper and vial, respectively and 484 of the transferset 462. The collar 440 further includes a tubular portion which is integral with the radial portion 490, which surrounds the transferset 462. In this embodiment, the distal tubular portion 496 has an internal diameter greater than the internal diameter of the proximate tubular portion 494 to more easily accommodate receipt of a syringe or intravenous (IV) set connector during use of the transferset. In the disclosed embodiment, the distal end of the collar includes a radial flange 498 and the distal open end of the collar is sealed with a peel-off seal 500 formed of paper, plastic, aluminum or foil which is adhesively bonded to the radial flange portion 498 providing easy access to the transferset 462.

The plastic collar and transferset assembly of this invention shown in Figure 9 may be utilized to transfer fluid between the vial 22 or other suitable container and a conventional syringe, intravenous set or the like. The seal is removed by removing the peel-off seal 500 which provides access to the transferset 462. A conventional syringe (not shown) having a female Luer Lock connector, for example, may be threaded on the male Luer Lock connector 468. As the Luer connectors of the

tubular transfer member 464 and syringe are threaded together, the nozzle portion of the syringe is received in the tubular transfer member which simultaneously drives the piercing end 470 of the piercing member 466 through the central portion 38 of the elastomeric stopper providing fluid communication between the vial 22 and the interior of the tubular transfer member 464 through external channel 472. In a typical application, drugs in a dry or powdered form may be stored in the vial 22 to increase the shelf life of the drug. The syringe may be utilized to transfer a diluent or solvent into the vial to reconstitute the drug which may then be withdrawn into the syringe for application to a patient.

Figure 10 illustrates a further alternative embodiment of the plastic collar and transferset of this invention wherein the entire cap is removable. The transferset 462 including the tubular transfer member 464 and piercing member 466 may be identical to the transferset disclosed in Figure 9. Further, the vial 22 and elastomeric stopper 32 are conventional as shown in Figure 9.

The embodiment of the plastic collar 540 shown in Figure 10 includes a tubular portion 542 which surrounds the planar rim portion 36 of the stopper having internal longitudinal spaced ribs 543 which receives the rim portion 26 of the vial to assure preassembly of the components on the vial prior to crimping. The free end 544 of the collar is deformed radially or crimped beneath the rim portion 26 of the stopper as described above. The internal surface of the free end 544 of the collar further includes an elastomeric O-ring 488 as described above which is resiliently deformed against the rim portion 26 of the vial preventing rotation of the collar on the vial. In this embodiment of the plastic collar 540, the radial portion 546 overlies the radial portion 484 of the tubular transfer member and the tubular portion 548 is spaced inwardly from the tubular portion 542 to receive a cup-shaped cap 550. As shown, the cup-shaped cap 550 includes a cylindrical proximate portion 552, a conical portion 554 and a closed end portion 556. In this embodiment, the cap 550 is secured to the plastic collar 540 by a twist-off preslit label 560 made of plastic, aluminum or foil which provides evidence of tampering. The cap 550 may then be easily removed by breaking or rupturing the seal 560 providing access to the transferset 462.

The plastic collar 640 as shown in Figure 11 is similar to the collar and transferset assembly shown in Figure 9 except that the tubular transfer member 664 is formed integral with the outer tubular portion 682 thereby simplifying the design and permitting molding of these parts of the transferset in one piece, which also simplifies assembly and reduces the cost. The components of the integral collar and transferset assembly of Figure 11 has been numbered where practical in the same sequence as the collar and transferset assembly of Figure 9. Briefly, the transferset 662 includes a tubular transfer member or portion 664 and a piercing member 466 which in this embodiment is identical to the piercing member 466 shown in Figure 9 and described above. The tubular member 664 includes a Luer Lock connection 668 which in the disclosed embodiment are male threads on the exterior surface of the tubular transfer member. As described above, the tubular transfer member or portion 664 includes a proximate internal surface 674 and a distal internal surface 675 having a diameter less than the internal diameter of the proximate internal surface 764 to define a lip 676 which receives the radial flange 478 of the piercing member 466, such that the piercing member 466 is retained in the tubular transfer portion 664 for telescopic movement of the piercing member toward the central portion 638 of the stopper 632. In this embodiment, the elastomeric stopper 632 includes a planar portion 636 which is received on the rim 26 of the vial 22 as described above; however, in this embodiment of the stopper 632, which is also conventional, the generally tubular portion 634 which extends into the internal surface 31 of the vial is thicker and the internal surface is arcuate defining an arcuate central portion 638 which receives the piercing end 470 of the piercing member 466.

The proximate end of the tubular transfer portion 664 in the disclosed embodiment also includes a relatively sharp edge 680 which is pressed into the central portion 638 of the elastomeric stopper during assembly as described above. The plastic collar 640 of this embodiment includes a tubular portion 642 which surrounds the planar rim 636 of the elastomeric stopper and the radial rim 26 of the vial. In this embodiment, however, the internal surface of the tubular portion 642 and the radial portion 684 includes a plurality of spaced ribs 643 which are pressed into the planar portion 636 of the elastomeric stopper, preventing rotation of the collar 640 and

transferset on the vial. As described above, the integral collar and transferset is permanently secured to the vial by permanently radially deforming the free end 644 inwardly around the rim portion 26 of the vial which includes an elastomeric O-ring 688 which also limits rotation of the collar 640 on the vial 22 and an additional seal of the assembly. The outer tubular portion 682 is formed integral with the tubular transfer portion 664 by an integral radial annular web 670 forming a rigid assembly which is simpler in design and less costly as described above. The radial portion 684 of the outer tubular portions 682 includes an annular barb 686 having the same function as the barb 486 described above. Other details of the preferred embodiment of the integral collar and transferset assembly shown in Figure 11 will be understood from the description above. As will be understood by those skilled in the art, however, the integral design of the collar 640, outer tubular member 682 and the tubular transfer member 664 may be injection molded in one piece forming a relatively rigid structure which eliminates assembly of the individual components and reduces costs.

The peel-off seal 600 shown in Figures 11 and 12 seals the internal components of the transferset 662, may be easily removed and provides an indication of tampering. The disclosed embodiment of the seal 600 includes a sealing portion 602 which in the disclosed embodiment is circular to accommodate the shape of a conventional vial and may be formed of paper, plastic, aluminum or foil which is adhesively bonded to the radial flange portion 698 of the outer tubular portions 682 as described above. This embodiment, however, includes an integral tab 604 including a central portion 606 which is welded or adhesively bonded to the outer tubular portion 682 of the transferset by glue 608. Securing the central portion 606 of the seal to the transferset prevents inadvertent removal of the seal and evidence of tampering. The free end 610 of the tab may be easily gripped for peeling off the seal 600 from the transferset.

As described in regard to the embodiments of the plastic cap shown in Figures 1 to 5, the plastic collar 440 in Figure 9, 546 in Figure 10 and 640 in Figure 11 are preferably secured to the vial 22 by compressing the radial portion 490 in Figure 9, 546 in Figure 10 or 684 in Figure 11 against the resilient planar portion of the

stopper. In the embodiments shown in Figures 9 and 10, the radial portion 490 in Figure 9 or 546 in Figure 10 is compressed against the radial portion 484 of the tubular transfer member, which compresses the radial portion and the annular barb 486 against the resilient planar rim portion 36 of the elastomeric stopper during radial deformation of the free end 444 in Figure 9 and 544 in Figure 10 of the collar beneath the rim 26 of the vial, thereby sealing the vial and securing the collar to the vial. In the simplified embodiment of the integral collar and transferset shown in Figure 11, the radial portion 684 of the outer tubular portion 682 of the transferset is compressed directly against the planar portion 636 of the resilient elastomeric stopper, which compresses the annular barb 686 against the planar rim portion 636 of the stopper during radial deformation of the free end 644 of the collar portion 640 forming a tight seal. The plastic collar 440 and the integral outer tubular portion 494 in Figure 9, 540 in Figure 10 and the integral collar 640, outer tubular portion 682 and tubular transfer portion 664 are preferably formed of a polymer having the physical properties and characteristics described above, thereby permitting crimping of the collar on a vial or other container. More preferably, the plastic collar is formed of a polymeric melt blend or alloy including a tough relatively soft malleable polymer and a relatively rigid polymer and most preferably a polymeric alloy including polycarbonate and polyester. As will be understood, however, various modifications may be made to the plastic closure of this invention within the purview of the appended claims.

CLAIMS

1. A plastic closure for sealing a container having an open end and a reduced diameter portion adjacent said open end, said plastic closure having a generally tubular portion and a portion which is permanently deformed radially into said reduced diameter portion of said container, said plastic closure formed of a polymer which is sufficiently malleable to permit radial deformation, yet sufficiently rigid to retain its shape following deformation and sufficiently resistant to creep to maintain the seal between said plastic closure and said container following radial deformation.

2. The plastic closure for sealing a container as defined in Claim 1, wherein said polymer is relatively clear and maintains its clarity under the stress of deformation.

3. The plastic closure for sealing a container as defined in Claims 1 or 2, wherein said plastic closure is formed of a composite polymer including a relatively soft malleable polymer and a relatively rigid polymer.

4. The plastic closure for sealing a container as defined in Claim 3, wherein said closure is formed of a polymeric alloy comprising a soft malleable co-polymer and said relatively rigid polymer.

5. The plastic closure for sealing a container as defined in Claims 3 or 4, wherein said relatively rigid polymer is a polycarbonate or polyamid.

6. The plastic closure for sealing a container as defined in Claims 3 or 4, wherein said relatively soft polymer is a polyester or polyolefin.

7. The plastic closure for sealing a container as defined in Claim 1, wherein said polymer has an elongation at yield between 5% and 10% and an

elongation at brake greater than 100% with a flexual modulus of greater than 1,800 MPa.

8. The plastic closure for sealing a container as defined in Claim 1, wherein said container includes a radial rim adjacent said open end, said plastic closure having a tubular portion surrounding said container rim and an integral radial rim portion received over said rim of said container and said tubular portion having a free end deformed radially inwardly beneath said rim of said container, and said cylindrical tubular portion of said closure including an annular resilient ring retained on an internal surface adjacent said free end preventing rotation of said closure on said container.

9. The plastic closure for sealing a container as defined in Claim 1, wherein said container includes a radial rim adjacent said open end and an elastomeric stopper having a portion received within said open end of said container having a radial rim portion overlying said rim portion of said container, said closure having a tubular portion surrounding said rim portion of said container having a free distal end deformed radially inwardly beneath said rim portion of said container and an integral proximate radial portion overlying said rim portion of said stopper.

10. The plastic closure for sealing a container as defined in Claim 9, wherein said proximate radial portion of said closure includes a central opening overlying a central portion of said stopper and said closure including a cup-shaped cap having a tubular portion overlying a proximate portion of said closure and a radial portion overlying said central opening of said closure and said cap secured to said closure by retainer elements received within said central opening of said closure.

11. The plastic closure for sealing a container as defined in Claim 10, wherein said retainer elements are spaced U-shaped tabs integral with said cap received through said central opening of said closure each having a free end engaging a portion of said closure adjacent said central opening.

12. The plastic closure for sealing a container as defined in Claim 8, wherein said internal surface of said cylindrical tubular portion includes an annular groove adjacent said free end and said ring is received in said annular groove.

13. The plastic closure for sealing a container as defined in Claim 8, wherein said plastic closure is formed by injection molding and said annular ring is formed of an elastomeric material co-injected with said closure or integrally bonded on said internal surface adjacent said distal end.

14. The plastic closure for sealing a container as defined in Claim 1, wherein said plastic closure includes an elastomeric coating on an internal surface of a free end of said tubular portion and said elastomeric coating integrally bonded to said internal surface.

15. The plastic closure for sealing a container as defined in Claim 1, wherein said tubular portion includes a proximate end having a radial portion adapted to overlie a container rim and an integral second tubular portion adapted to receive and surround a transferset for transferring fluid from said first container to a second container.

16. The plastic closure for sealing a container as defined in Claim 15, wherein said second tubular portion includes an integral tubular transfer member located within said second tubular portion forming a part of said transferset.

17. A method of sealing a container with a plastic closure, said container having an open end, a radial rim portion surrounding said open end, a reduced diameter neck portion adjacent said radial rim and an enclosed container portion adjacent said neck portion, said method comprising:

forming a plastic closure including a generally cylindrical tubular portion having an internal diameter generally equal to or slightly greater than an outside diameter of said rim portion and an integral radial rim portion;

disposing said closure over said rim of said container with said radial rim portion overlying said rim portion of said container and said generally cylindrical tubular portion surrounding said container rim and having a free end overlying said neck portion; and

radially permanently deforming said free end of said generally cylindrical tubular portion of said closure into said neck portion of said container beneath said rim portion, permanently securing said closure on said container and sealing said container open end.

18. The method of sealing a container with a plastic closure as defined in Claim 17, wherein said method includes forming said plastic closure of a relatively clear composite polymer including a relatively soft malleable polymer and a relatively rigid polymer and radially permanently deforming said free end of said generally cylindrical tubular portion of said closure while maintaining the clarity of said plastic closure.

19. The method of sealing a container with a plastic closure as defined in Claim 17, wherein said method includes injection molding said plastic closure from a polymer alloy comprising a relatively malleable soft polymer and a relatively rigid polymer, wherein said polymer alloy is formed during said injection molding.

20. The method of sealing a container with a plastic closure as defined in Claim 17, wherein said method includes retaining an elastomeric ring on an internal surface of said generally cylindrical tubular portion adjacent said free end prior to radially deforming said free end, then radially deforming said free of said generally cylindrical tubular portion of said closure and said elastomeric ring against a surface of said rim portion of said container, said elastomeric ring preventing rotation of said closure on said container.

21. The method of sealing a container with a plastic closure as defined in Claim 20, wherein said method includes forming an annular groove in said internal

surface of said cylindrical tubular portion adjacent said free end and then inserting said annular elastomeric ring in said groove.

22. The method of sealing a container with a plastic closure as defined in Claim 20, wherein said method includes forming said plastic closure by injection molding said plastic closure and co-injecting said annular elastomeric ring, integrally bonding said elastomeric ring on an internal surface of said generally cylindrical tubular portion adjacent said free end.

23. The method of sealing a container with a plastic closure as defined in Claim 17, wherein said method includes forming said closure of a polyamid polymer or a composite polymer having a relatively rigid soft malleable co-polymer and a relatively rigid polymer

24. The method of sealing a container with a plastic closure as defined in Claim 23, wherein said method includes co-injecting a polymer alloy including polycarbonate as said relatively rigid polymer.

25. The method of sealing a container with a plastic closure as defined in Claim 17, wherein said method includes co-injecting a polymer forming said closure and a thermoplastic polymer on an inside surface of said free end of said closure integrally bonding said thermoplastic polymer to said polymer forming said closure.

26. The method of sealing a container with a plastic closure as defined in Claim 17, wherein said method includes inserting an elastomeric stopper in said open end of said container, then disposing said closure over said rim portion of said container and said stopper and simultaneously compressing said elastomeric stopper rim portion and radially permanently deforming said closure cylindrical tubular portion free end.

27. A sealed vial and transferset assembly comprising a vial having an open end, a radial rim portion surrounding said open end and a reduced diameter neck portion adjacent said rim portion, and a transferset mounted on said vial open end of said vial for transferring fluid between said vial and a container, said transferset including a plastic collar having a tubular portion surrounding said rim portion of said vial having a free end permanently deformed radially inwardly into said vial neck portion retaining said transferset on said vial, said plastic collar formed of a polymer which is sufficiently malleable to permit radial deformation, yet sufficiently rigid to retain its shape following deformation and sufficiently resistant to creep to maintain the seal between said collar and said vial following deformation.

28. The sealed vial and transferset assembly defined in Claim 27, wherein said transferset includes a fluid transfer assembly mounted on said vial open end and said plastic collar includes an integral tubular portion surrounding at least a portion of said fluid transfer assembly.

29. The sealed vial and transferset assembly as defined in Claim 28, wherein said fluid transfer assembly includes a tubular transfer member located within said integral tubular portion integral with said integral tubular portion.

30. The sealed vial and transferset assembly as defined in Claim 29, wherein said tubular transfer member includes a free distal open end having a Luer Lock connector.

31. The sealed vial and transferset assembly as defined in Claim 30, wherein said tubular transfer member includes an integral radial web spaced from said Luer Lock connector integrally joined to said integral tubular portion surrounding said tubular transfer member.

32. The sealed vial and transferset assembly defined in Claim 28, wherein said plastic collar has a closed end portion, sealing said fluid transfer assembly therein.

33. The sealed vial and transferset assembly defined in Claim 32, wherein said closed end comprises a sealing member affixed to a free open end of said plastic collar.

34. The sealed vial and transferset assembly defined in Claim 27, wherein said plastic collar is formed of a polyamid polymer or a composite polymer including a relatively soft malleable co-polymer and a relatively rigid polymer.

35. The sealed vial and transferset assembly defined in Claim 34, wherein said plastic collar is formed of a polymer alloy comprising a relatively soft malleable co-polymer and polycarbonate as said relatively rigid polymer.

36. The sealed vial and transferset assembly defined in Claim 27, wherein said tubular portion of said plastic collar includes an annular resilient ring retained on an internal surface of said collar adjacent said free end biased against said vial radial rim portion and preventing rotation of said collar on said vial.

37. The sealed vial and transferset assembly defined in Claim 36, wherein said internal surface of said tubular portion includes an annular groove adjacent said free end and said resilient ring is received and retained in said annular groove.

38. The sealed vial and transferset assembly defined in Claim 27, wherein said tubular portion of said plastic collar includes an elastomeric coating on an internal surface thereof integrally bonded to said internal surface.

AMENDED CLAIMS

[received by the International Bureau on 19 August 1999 (19.08.99);
original claims 1 – 38 replaced by new claims 1 – 42 (8 pages)]

1. A plastic closure for sealing a container having an open end and a reduced diameter portion adjacent said open end, said plastic closure having a generally tubular portion and a portion which is permanently deformed radially into said reduced diameter portion of said container, said plastic closure formed of a polymer which is sufficiently malleable to permit radial deformation, yet sufficiently rigid to retain its shape following deformation and sufficiently resistant to creep to maintain the seal between said plastic closure and said container following radial deformation.

2. The plastic closure for sealing a container as defined in Claim 1, wherein said polymer is relatively clear and maintains its clarity under the stress of deformation.

3. The plastic closure for sealing a container as defined in Claims 1 or 2, wherein said plastic closure is formed of a composite polymer including a relatively soft malleable polymer and a relatively rigid polymer.

4. The plastic closure for sealing a container as defined in Claim 3, wherein said closure is formed of a polymeric alloy comprising a soft malleable co-polymer and said relatively rigid polymer.

5. The plastic closure for sealing a container as defined in Claims 3 or 4, wherein said relatively rigid polymer is a polycarbonate or polyamid.

6. The plastic closure for sealing a container as defined in Claims 3 or 4, wherein said relatively soft polymer is a polyester or polyolefin.

7. The plastic closure for sealing a container as defined in Claim 1, wherein said polymer has an elongation at yield between 5% and 10% and an

elongation at brake greater than 100% with a flexual modulus of greater than 1,800 MPa.

8. The plastic closure for sealing a container as defined in Claim 1, wherein said container includes a radial rim adjacent said open end, said plastic closure having a tubular portion surrounding said container rim and an integral radial rim portion received over said rim of said container and said tubular portion having a free end deformed radially inwardly beneath said rim of said container, and said cylindrical tubular portion of said closure including an annular resilient ring retained on an internal surface adjacent said free end preventing rotation of said closure on said container.

9. The plastic closure for sealing a container as defined in Claim 1, wherein said container is a medical vial or cartridge including a radial rim adjacent said open end and a pierceable sealing element sealing said open end of said container, said closure having a tubular portion surrounding said rim portion of said container having a free distal end deformed radially inwardly beneath said rim portion of said container and an integral proximate radial portion overlying said sealing element.

10. The plastic closure for sealing a container as defined in Claim 9, wherein said proximate radial portion of said closure includes a central opening overlying a central portion of said sealing element and said closure including a cup-shaped cap having a tubular portion overlying a proximate portion of said closure and a radial portion overlying said central opening of said closure and said cap secured to said closure by retainer elements received within said central opening of said closure.

11. The plastic closure for sealing a container as defined in Claim 10, wherein said retainer elements are spaced U-shaped tabs integral with said cap received through said central opening of said closure each having a free end engaging

a portion of said closure adjacent said central opening.

12. The plastic closure for sealing a container as defined in Claim 8, wherein said internal surface of said cylindrical tubular portion includes an annular groove adjacent said free end and said ring is received in said annular groove.

13. The plastic closure for sealing a container as defined in Claim 8 wherein said plastic closure is formed by injection molding and said annular ring is formed of an elastomeric material co-injected with said closure or integrally bonded on said internal surface adjacent said distal end.

14. The plastic closure for sealing a container as defined in Claim 1, wherein said plastic closure includes an elastomeric coating on an internal surface of a free end of said tubular portion and said elastomeric coating integrally bonded to said internal surface.

15. The plastic closure for sealing a container as defined in Claim 1, wherein said container is a vial having a radial rim portion adjacent said open end and an elastomeric stopper having a portion received in said open end of said container and a radial rim portion overlying said vial radial rim portion, said closure having a tubular portion surrounding said rim portions of said stopper and said vial having a free distal end deformed radially inwardly beneath said rim portion of said vial and compressing said rim portion of said elastomeric stopper.

16. The plastic closure for sealing a container as defined in Claim 1, wherein said container is a medical cartridge including an elastomeric seal sealing said open end of said cartridge having a radial rim portion overlying said open end of said cartridge, said closure having a tubular portion surrounding said rim portions of said cartridge and said sealing element including a free distal end deformed radially inwardly around said cartridge adjacent said open end compressing said rim portion of said sealing element.

17. The plastic closure for sealing a container as defined in Claim 1, wherein said tubular portion includes a proximate end having a radial portion adapted to overlie a container rim and an integral second tubular portion adapted to receive and surround a transferset for transferring fluid from said first container to a second container.

18. The plastic closure for sealing a container as defined in Claim 17, wherein said second tubular portion includes an integral tubular transfer member located within said second tubular portion forming a part of said transferset.

19. A method of sealing a container with a plastic closure, said container having an open end, a radial rim portion surrounding said open end, a reduced diameter neck portion adjacent said radial rim and an enclosed container portion adjacent said neck portion, said method comprising:

forming a plastic closure including a generally cylindrical tubular portion having an internal diameter generally equal to or slightly greater than an outside diameter of said rim portion and an integral radial rim portion;

disposing said closure over said rim of said container with said radial rim portion overlying said rim portion of said container and said generally cylindrical tubular portion surrounding said container rim and having a free end overlying said neck portion; and

radially permanently deforming said free end of said generally cylindrical tubular portion of said closure into said neck portion of said container beneath said rim portion, permanently securing said closure on said container and sealing said container open end.

20. The method of sealing a container with a plastic closure as defined in Claim 19, wherein said method includes forming said plastic closure of a relatively clear composite polymer including a relatively soft malleable polymer and a relatively rigid polymer and radially permanently deforming said free end of said generally

cylindrical tubular portion of said closure while maintaining the clarity of said plastic closure.

21. The method of sealing a container with a plastic closure as defined in Claim 19, wherein said method includes injection molding said plastic closure from a polymer alloy comprising a relatively malleable soft polymer and a relatively rigid polymer, wherein said polymer alloy is formed during said injection molding.

22. The method of sealing a container with a plastic closure as defined in Claim 19, wherein said method includes retaining an elastomeric ring on an internal surface of said generally cylindrical tubular portion adjacent said free end prior to radially deforming said free end, then radially deforming said free of said generally cylindrical tubular portion of said closure and said elastomeric ring against a surface of said rim portion of said container, said elastomeric ring preventing rotation of said closure on said container.

23. The method of sealing a container with a plastic closure as defined in Claim 22, wherein said method includes forming an annular groove in said internal surface of said cylindrical tubular portion adjacent said free end and then inserting said annular elastomeric ring in said groove.

24. The method of sealing a container with a plastic closure as defined in Claim 22, wherein said method includes forming said plastic closure by injection molding said plastic closure and co-injecting said annular elastomeric ring, integrally bonding said elastomeric ring on an internal surface of said generally cylindrical tubular portion adjacent said free end.

25. The method of sealing a container with a plastic closure as defined in Claim 19, wherein said method includes forming said closure of a polyamid polymer or a composite polymer having a relatively rigid soft malleable co-polymer and a relatively rigid polymer

26. The method of sealing a container with a plastic closure as defined in Claim 25, wherein said method includes co-injecting a polymer alloy including polycarbonate as said relatively rigid polymer.

27. The method of sealing a container with a plastic closure as defined in Claim 19 wherein said method includes co-injecting a polymer forming said closure and a thermoplastic polymer on an inside surface of said free end of said closure integrally bonding said thermoplastic polymer to said polymer forming said closure.

28. The method of sealing a container with a plastic closure as defined in Claim 19, wherein said method includes sealing said open end of said container with an elastomeric sealing element having a radial rim portion overlying said rim portion of said container, then disposing said closure over said rim portion of said container and said sealing element and simultaneously compressing said elastomeric sealing element rim portion and radially permanently deforming said closure cylindrical tubular portion free end.

29. The method of sealing a container with a plastic closure as defined in Claim 19, wherein said container is a medical vial, said method including sealing said open end of said vial with an elastomeric stopper having a portion received within said open end of said vial and a radial rim portion overlying said radial rim portion of said vial and compressing said radial rim portion of said elastomeric stopper as said free end of said closure is deformed radially into said neck portion of said vial.

30. The method of sealing a container with a plastic closure as defined in Claim 19, wherein said container is a medical cartridge, said method including sealing said open end of said cartridge with an elastomeric sealing element having a radial rim portion overlying said radial rim portion of said cartridge and deforming said radial rim portion of said sealing element as said free end of said generally cylindrical tubular portion of said closure is permanently deformed radially into said neck portion of said cartridge beneath said rim portion.

31. A sealed vial and transferset assembly comprising a vial having an open end, a radial rim portion surrounding said open end and a reduced diameter neck portion adjacent said rim portion, and a transferset mounted on said vial open end of said vial for transferring fluid between said vial and a container, said transferset including a plastic collar having a tubular portion surrounding said rim portion of said vial having a free end permanently deformed radially inwardly into said vial neck portion retaining said transferset on said vial, said plastic collar formed of a polymer which is sufficiently malleable to permit radial deformation, yet sufficiently rigid to retain its shape following deformation and sufficiently resistant to creep to maintain the seal between said collar and said vial following deformation.

32. The sealed vial and transferset assembly defined in Claim 31, wherein said transferset includes a fluid transfer assembly mounted on said vial open end and said plastic collar includes an integral tubular portion surrounding at least a portion of said fluid transfer assembly.

33. The sealed vial and transferset assembly as defined in Claim 32, wherein said fluid transfer assembly includes a tubular transfer member located within said integral tubular portion integral with said integral tubular portion.

34. The sealed vial and transferset assembly as defined in Claim 33, wherein said tubular transfer member includes a free distal open end having a Luer Lock connector.

35. The sealed vial and transferset assembly as defined in Claim 34, wherein said tubular transfer member includes an integral radial web spaced from said Luer Lock connector integrally joined to said integral tubular portion surrounding said tubular transfer member.

36. The sealed vial and transferset assembly defined in Claim 32, wherein said plastic collar has a closed end portion, sealing said fluid transfer assembly

therein.

37. The sealed vial and transferset assembly defined in Claim 36, wherein said closed end comprises a sealing member affixed to a free open end of said plastic collar.

38. The sealed vial and transferset assembly defined in Claim 31, wherein said plastic collar is formed of a polyamid polymer or a composite polymer including a relatively soft malleable co-polymer and a relatively rigid polymer.

39. The sealed vial and transferset assembly defined in Claim 38, wherein said plastic collar is formed of a polymer alloy comprising a relatively soft malleable co-polymer and polycarbonate as said relatively rigid polymer.

40. The sealed vial and transferset assembly defined in Claim 31, wherein said tubular portion of said plastic collar includes an annular resilient ring retained on an internal surface of said collar adjacent said free end biased against said vial radial rim portion and preventing rotation of said collar on said vial.

41. The sealed vial and transferset assembly defined in Claim 40, wherein said internal surface of said tubular portion includes an annular groove adjacent said free end and said resilient ring is received and retained in said annular groove.

42. The sealed vial and transferset assembly defined in Claim 31, wherein said tubular portion of said plastic collar includes an elastomeric coating on an internal surface thereof integrally bonded to said internal surface.

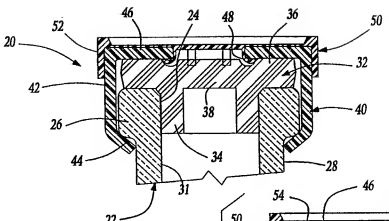


Fig-1

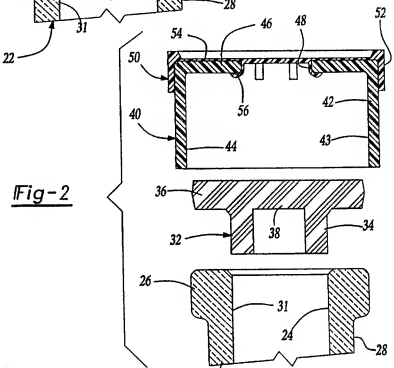


Fig-2

Fig-3

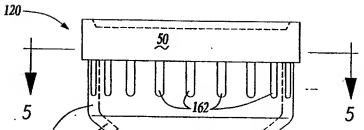


Fig-4

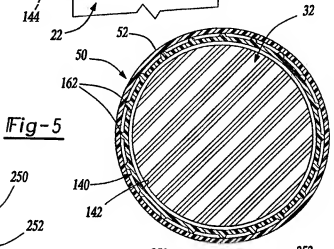


Fig-5

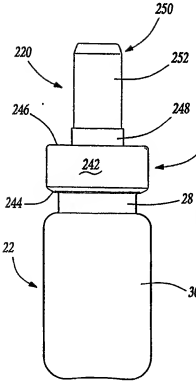


Fig-6

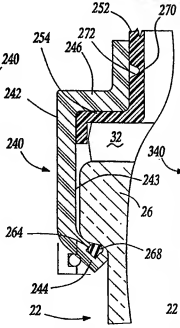


Fig-7

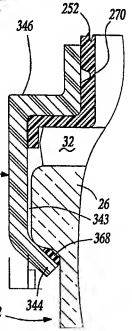


Fig-8

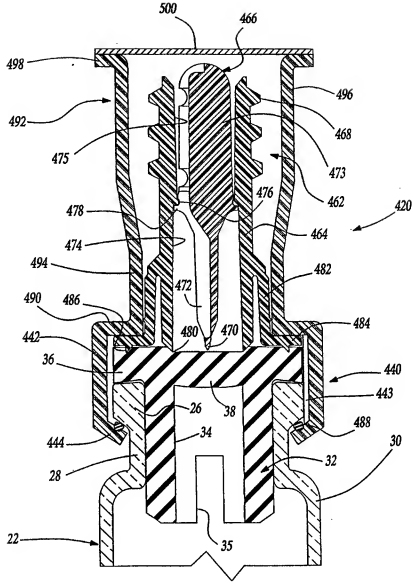

500
466
498
496
492
468
475
473
476
462
420
478
464
474
494
482
472
490
486
484
480
470
442
36
440
443
26
38
488
444
34
30
28
32
22
35

Fig-9

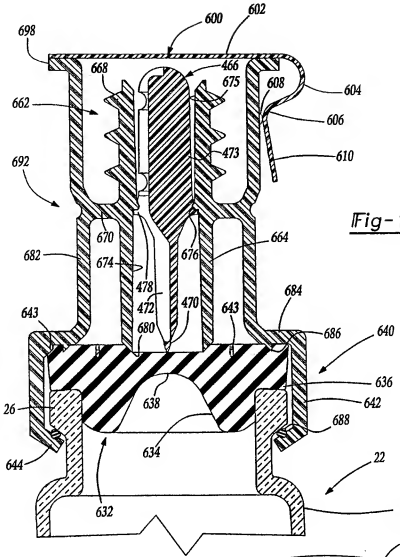

600
602
698
668
466
675
608
604
662
606
473
610
692
664
670
682
674
676
478
472
470
643
643
680
684
686
640
636
638
642
26
688
634
644
22
632
30

Fig-11

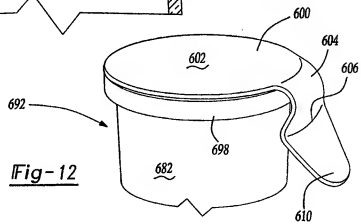

600
604
602
606
692
698
682
610

Fig-12

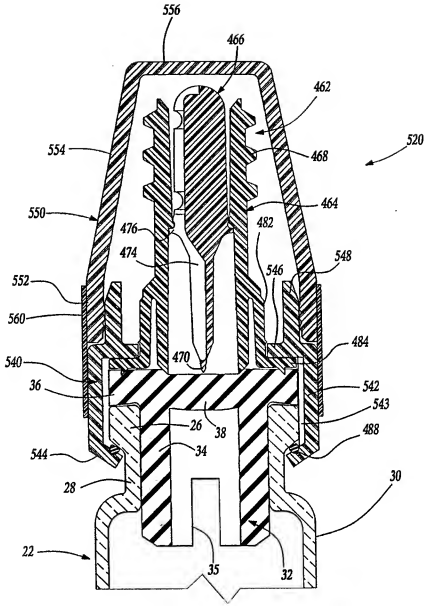

556
466
462
554
468
520
550
464
476
482
474
546
548
552
560
484
540
470
36
542
543
26
38
544
34
488
28
30
22
35
32

Fig-10

APPENDIX F

US 6,706,031 ("Manera")

US006706031B2

(12) **United States Patent**
Manera

(10) **Patent No.: US 6,706,031 B2**
(45) **Date of Patent: Mar. 16, 2004**

(54) **NEEDLELESS ACCESS APPARATUS AND SYSTEM**

(75) Inventor: **David A. Manera**, Petersburg, NJ (US)

(73) Assignee: **Comar, Inc.**, Buena, NJ (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 26 days.

(21) Appl. No.: **09/781,595**

(22) Filed: **Feb. 12, 2001**

(65) **Prior Publication Data**

US 2003/0055395 A1 Mar. 20, 2003

Related U.S. Application Data

(60) Provisional application No. 60/182,628, filed on Feb. 15, 2000.

(51) **Int. Cl.**[7] **A61M 5/32**; A61M 25/16

(52) **U.S. Cl.** 604/411; 604/535; 604/905; 604/414

(58) **Field of Search** 604/411, 414, 604/415, 905, 205, 206, 412, 413, 533, 201, 534, 535, 537

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,171,214 A * 12/1992 Kolber et al. 604/82
6,253,804 B1 * 7/2001 Safabash 141/97

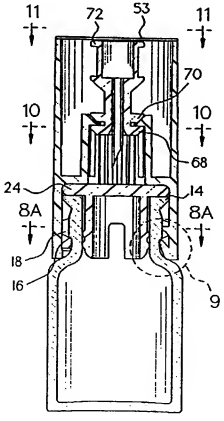
* cited by examiner

Primary Examiner—Michael J. Hayes
Assistant Examiner—Lina R Kontos
(74) *Attorney, Agent, or Firm*—Eugene E. Renz, Jr.

(57) **ABSTRACT**

A needleless access system adapted to be mounted on a vial comprising a generally elongated tubular housing having an interior dividing wall, flexible hooks projecting upwardly from the dividing wall which are diametrically opposed, a pair of confronting splines projecting upwardly from the interior dividing wall, a hub insert having a piercing tip normally supported in an armed position by hook elements, a series of outwardly projecting teeth which engage and are guided in the splines during axial displacement of the hub insert relative to the splined housing, and said hub insert having means for mounting a syringe assembly whereby the hub insert maybe activated axially guided by the splines so that the piercing tip engages the stopper in a vial aligned therewith.

3 Claims, 8 Drawing Sheets



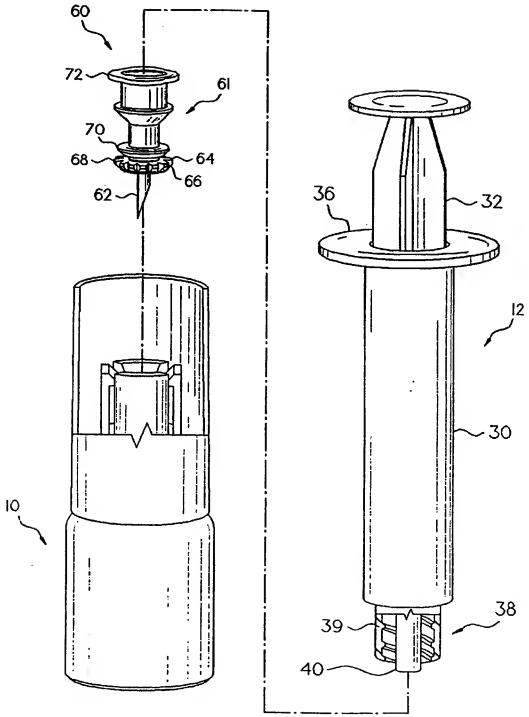


Fig. 1

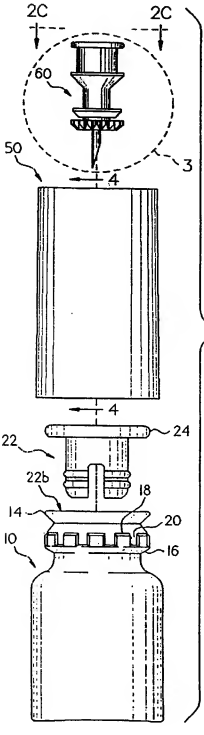


Fig- 2A

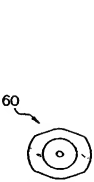


Fig- 2C

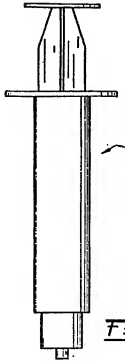


Fig- 2B

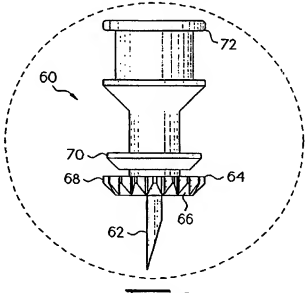


Fig- 3

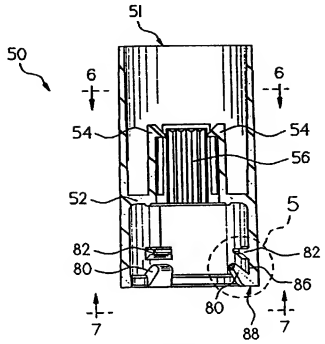


Fig. 4

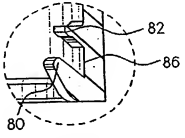


Fig. 5

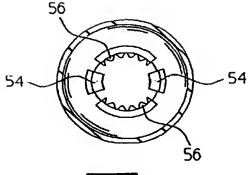


Fig. 6

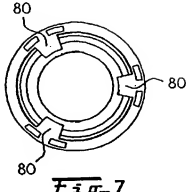


Fig. 7

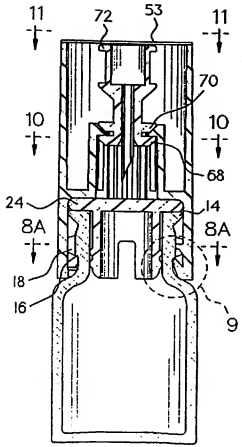


Fig. 8

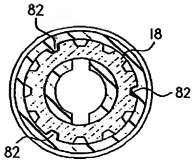


Fig. 8A

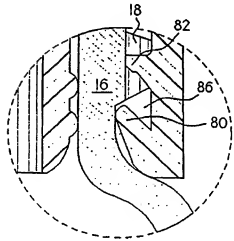


Fig. 9

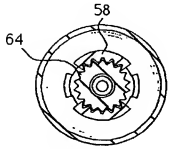


Fig. 10

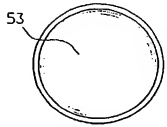


Fig. 11

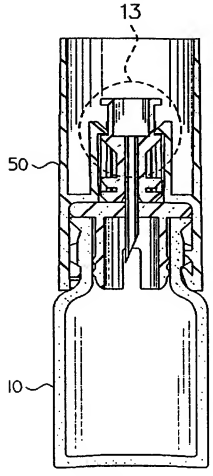


Fig. 12

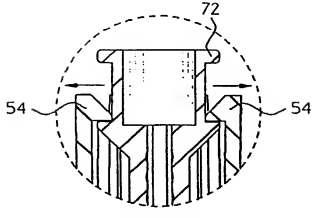


Fig. 13

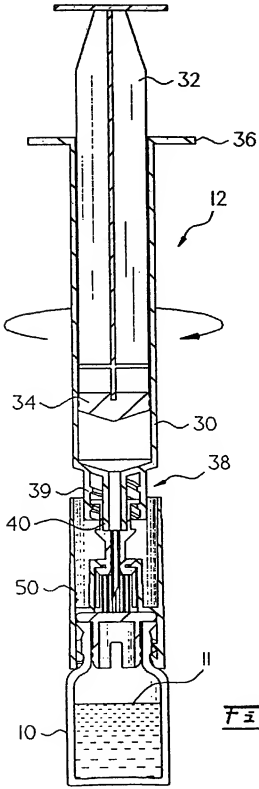


Fig. 14

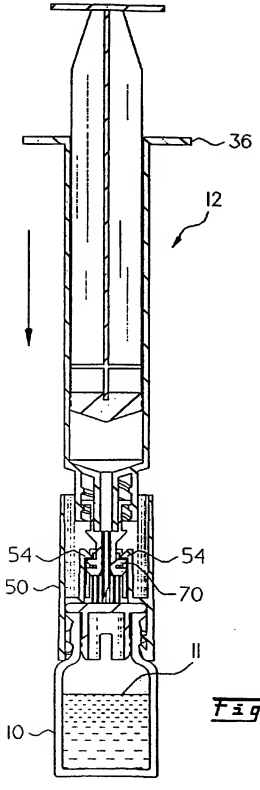


Fig. 15

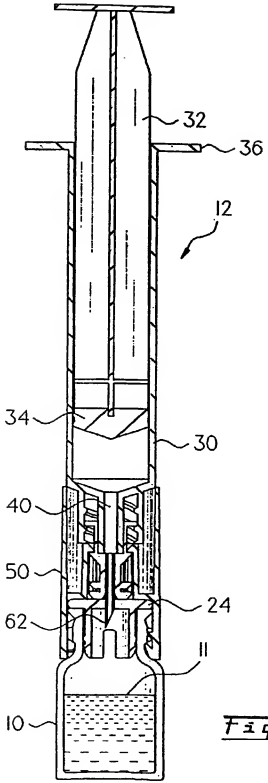


Fig. 16

NEEDLELESS ACCESS APPARATUS AND SYSTEM

This application claims the benefit of U.S. Provisional Application No. 60/182,628 filed Feb. 15, 2000.

FIELD OF THE INVENTION

The present invention relates to needleless access systems for use in the medical field whereby medicaments can be withdrawn from vials into a syringe without exposing the user to a sharp syringe needle. More specifically, the present invention provides a novel piercing assembly for mounting on a stoppered vial and configured to receive the fitting of a syringe barrel to activate the system and withdraw the contents of the vial.

BACKGROUND OF THE INVENTION

Activation systems, generally of the type to which the present invention relates are not new per se. For example, the Ameas U.S. Pat. No. 5,879,345, issued Mar. 9, 1999 for DEVICE FOR CONNECTION WITH A CLOSED CONTAINER shows a system including a double pointed needle mounted in a sleeve overlying the stopper in one container which can be activated to transfer liquid products from one container to another.

The Weller U.S. Pat. No. 5,718,346 for a TORQUE-RESISTANT CLOSURE WITH A LUER INSERT FOR A HERMETICALLY SEALED CONTAINER discloses container closures generally, and more specifically, to an assembly providing a torque resistant closure for a hermetically sealed containers. Specifically, the invention resides in providing a pre-formed closure insert, which in the principal embodiment is designated by the numeral (**20**) permanently received in the neck portion of a container and formed with a thermoplastic material wherein the insert (**20**) is provided with a rough surface perimeter providing increased contact area between the insert (**20**) and the inner surface of the container neck or throat (**14**) contiguous therewith. One of the embodiments, namely that shown in FIG. **12**, incidentally shows an environment involving a transfer spike (**124**).

The Maietta et al. U.S. Pat. No. 5,482,176 for MEMBRANE PIERCING CLOSURE AND SPOUT ASSEMBLY, discloses a closure system for use particularly on cardboard packages or the like for milk and specifically, to a system for cutting an opening in such cardboard packages or cartons which functions as a pour spout. The closure pour spout assembly as shown in FIG. **4** comprises a closure cap (**32**), a spout member (**34**) and a piercing fitment (**26**) which inter-engage and nest in the manner shown in FIG. 4 and actuatable relative to one another between the nested position shown in FIG. **4** and an activated position wherein the piercing element creates a discharge opening in the carton to allow pouring of the contents.

Other prior art includes the patents listed below.

Kolber et al. U.S. Pat. No. 5,171,214 DRUG STORAGE AND DELIVERY SYSTEM Issued: Dec. 15, 1992

Szempruch et al. U.S. Pat. No. 5,755,712 TAMPER EVIDENCE FEATURE FOR STERILE PORT AND CAP SYSTEM Issued: May 26, 1998

Niedospial, Jr. et al. U.S. Pat. No. 5,817,082 MEDICAMENT CONTAINER CLOSURE WITH INTEGRAL SPIKE ACCESS MEANS Issued: Oct. 6, 1998

Jansen et al. U.S. Pat. No. 5,890,610 VIAL CONNECTOR ASSEMBLY FOR A MEDICAMENT CONTAINER Issued: Apr. 6, 1999

Daubert et al. U.S. Pat. No. 5,891,129 CONTAINER CAP ASSEMBLY HAVING AN ENCLOSED PENETRATOR Issued: Apr. 6, 1999

Niedospial, Jr. U.S. Pat. No. 5,895,383 MEDICAMENT CONTAINER CLOSURE WITH RECESSED INTEGRAL SPIKE ACCESS MEANS Issued: Apr. 20, 1999

Niedospial, Jr. et al. U.S. Pat. No. 5,902,298 MEDICAMENT CONTAINER STOPPER WITH INTEGRAL SPIKE ACCESS MEANS Issued: May 11, 1999

Avallone U.S. Pat. No. 5,919,182 MEDICAL FLUID TRANSFER AND DELIVERY DEVICE Issued: Jul. 6, 1999

SUMMARY OF THE INVENTION

The present invention provides an improvement over the prior art systems discussed above and is characterized by novel features of construction and arrangement facilitating easy and quick and is comprised of parts which are easy and economical to manufacture and which, when assembled, facilitating easy application of the syringe to withdraw the contents without exposing the user to risk of harm or injury from a needle puncture or the like.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other objects of the present invention and various features and details of the operation and construction thereof are hereinafter more fully set forth with reference to the accompanying drawings, wherein:

FIG. **1** is an exploded perspective view of the various components of the needleless access system of the present invention;

FIG. **2***a* is an exploded side elevational view of the components;

FIG. **2***b* is a side elevational view of the plunger and the plunger housing;

FIG. **2***c* is a top view of the piercing element taken along line **2***c*—**2***c* of FIG. **2***a*;

FIG. **3** is an enlarged side elevational view of the piercing element, shown n broken lines in FIG. **3**;

FIG. **4** is a transverse sectional view of the elongated sleeve for mounting the piercing element;

FIG. **5** is an enlarged fragmentary view of the portions circled in FIG. **4** for locking the device to the vial by way of flex-tangs;

FIG. **6** is a sectional view taken on lines **6**—**6** of FIG. **4**;

FIG. **7** is a bottom plan view of the sleeve as viewed along the lines of **7**—**7** of FIG. **4**;

FIG. **8** is a transverse sectional view of the needleless access system of the resent invention;

FIG. **8***a* is a sectional view taken on lines **8***a*—**8***a* of FIG. **8**;

FIG. **9** is an enlarged fragmentary view showing the mounting arrangement for mounting the sleeve on the vial;

FIG. **10** is a sectional view taken along line **10**—**10** of FIG. **8**;

FIG. **11** is a top view of the needleless access system of the present invention taken along line **11**—**11** of FIG. **8**;

FIG. **12** is a transverse sectional view showing the piercing element in an armed position;

FIG. **13** is an enlarged fragmentary view of the luer lock shown in broken lines of FIG. **12**;

FIG. **14** is a transverse sectional view showing a syringe barrel plunger mounted on the needle hub assembly;

FIG. **15** is a view similar to FIG. **14**, showing the parts about to be activated; and

FIG. **16** is a view showing the syringe needle piercing the stopper diaphragm so that the contents of the vial may be withdrawn into the syringe barrel.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawings and, more particularly to FIGS. **1-3** thereof, there is shown a needleless access system in accordance with the present invention for withdrawing medicaments from a vial (**10**) into a syringe (**12**). The vial (**10**) as best illustrated in FIG. **2***a*, has a finish including an outwardly flared lip (**14**) at the discharge end and a huttress ring (**16**) below the lip, consisting of a series of circumferentially spaced, radially outwardly projecting gears (**18**) defining there between a plurality of circumferentially spaced recesses (**20**). A stopper (**22**) seats in the discharge opening of the vial and has a radially outwardly directed flange (**24**) which engages the axial end face (**22***b*) of the lip (**14**) when it is seated in the vial in the manner shown in FIG. **8**.

The syringe assembly (**12**) comprises an elongated generally tubular or cylindrical barrel (**30**), an elongated plunger rod (**32**) engaging interiorly of the barrel (**30**) mounting a plunger (**34**) at its end and a finger grip portion (**36**) at its opposite end. The discharge end of the barrel, in the present instance, is a luer lock (**38**) comprising an interiorly threaded sleeve (**39**) spaced from the discharge tip (**40**) of the syringe (**12**).

The needleless access system further includes an elongated tubular housing (**50**) having an interior dividing wall (**52**). Two diametrically opposed flexible hooks (**54**) project upwardly from the inner edge of the dividing wall (**52**). A pair of arcuate splines (**56**) which are likewise diametrically opposed also project from the inner edge of the dividing wall (**52**). The hooks (**54**) and splines (**56**) provide a mounting arrangement for a hub insert (**60**) as shown in FIGS. **1** and **2***a*. The hub insert (**60**) has a piercing element (**62**) at its lower end, and a gear element (**64**) comprising a series of circumferentially extending radially, outwardly projecting teeth (**66**) which engage and are guided in the splines (**56**) to allow for axial displacement of the huh insert (**60**) in the spline housing (**50**) and wherein the inter-engagement of the teeth (**66**) with the splines (**56**) prevents rotation of the huh insert (**60**). The hub insert (**60**) has an enlarged hub portion (**61**) and is defined by a series of axially spaced, radially outwardly directed circumferentially extending rings, a lower ring (**68**), an intermediate ring (**70**), and an upper ring (**72**).

Considering now the lower portion of the main housing (**50**) below the dividing wall (**52**) has a series of circumferentially spaced tangs (**80**) which project radially inwardly and upwardly from the lower edge (**88**) of the housing, as illustrated in FIG. **4**. A companion rib (**82**) for each of the tangs (**80**) projects radially inwardly and is spaced from the tang (**80**) to define a gap (**86**) between the tang (**80**) and the rib (**82**). When the housing (**50**) is assembled to the vial (**10**), the tangs (**80**) engage under the buttress ring (**16**) to firmly seat the dividing wall (**52**) against the diaphragm or top wall (**24**) of the stopper (**22**) and the ribs (**82**) engage in the spaces (**20***a*) between the gear portions (**20**) so that the hub insert housing (**50**) cannot rotate relative to the vial.

Considering now operation and use of the needleless access system of the present invention. The major components of the present system, such as the hub insert (**60**), hub insert housing (**50**) and vial (**10**) and stopper (**22**) are pre-assemhled in the manner shown in FIG. **8** after the vial has been filled with a medicament under aseptic conditions. The opening at the top of the housing (**51**) may be covered with a foil induction seal (**53**) that maintains the inside of the housing (**50**) and the hub (**60**) sterile prior to use, the foil (**53**) being removed prior to activation. Note that in this position, the hub insert (**60**) is seated in an unarmed position (FIG. **8**) wherein the hook portions (**54**) of the spline housing (**50**) engage in the gap between the lower and intermediate rings (**70**) and the gear teeth (**66**) engage with the splines (**56**) to prevent rotation of the hub insert (**60**) in the spline housing (**50**).

Now when the doctor or nurse wants to withdraw the medicament content from the vial, the system is activated by removing the foil induction seal (**53**) from the top of the housing (**51**) (see FIG. **8**). This exposes the hub insert (**60**) and the syringe (**12**) can he assemhled simply by turning the threaded portion of the syringe over the upper ring (**72**) of the huh to lock the components together in the manner shown in FIG. **14**. The syringe (**12**), then, can be pushed downwardly in the direction of the arrows as shown in FIG. **15** which releases the huh insert (**60**) from the hooks (**54**) until the piercing element (**62**) passes through the diaphragm (**24**) in the manner shown in FIG. **16**. The nurse or doctor can then draw the syringe plunger (**34**) upwardly to evacuate the medicament (**11**) from the vial (**10**) and fill the syringe (**12**). When completed, the syringe (**12**) is simply rotated to release it from the huh insert (**60**). The housing (**50**), hub insert (**60**), and vial (**10**) do then comprise a disposable one-time unit.

The needleless access system component of the present invention holds compression on the stopper flange (**24**) or optional liner to maintain container/closure integrity. The compression is achieved by snapping the three flexible tangs (**80**) under the buttress ring (**16**) of the vial (**10**). There are also three horizontal ribs (**82**) that engage the gear portion of the vial (**10**). These ribs serve the purposes of holding the optional liner in position until placed on the vial, and they also hinder rotation of the huh-housing relative to the vial. In the upper portion of the huh-housing (**50**) there are two flexihle hooks 180 degrees apart, which are arranged around an internal spline (**56**). The hooks (**54**) are used to hold the huh (**60**) hetween the lower (**68**) and intermediate rings (**70**) and maintain the hub (**60**) in this position until activated. They also lock the huh (**60**) in the down or activated position by locking above the upper ring (**72**) on the huh once the spike pierces the rubber component. The internal spline (**56**) of the huh-housing (**50**) is used to engage the front gear diameter of the hub to eliminate rotation of the huh relative to the huh housing. The stopper finish gear vial is number 6. This needleless access system component has a combination gear and buttress ring (**16**). The huttress ring (**16**) is used as a locking feature for the flexible tangs (**80**) to lock below while the gear portion (**18**) is used to engage the horizontal ribs (**82**) of the huh-housing (**50**) to hinder rotation. The top of the vial (**10**) was designed with a special lip (**14**) to eliminate the pinching of the stopper flange (**24**) that occurred when placing the huh-housing over a standard gear finish vial (**10**). The special lip (**14**) allows the flange (**24**) to bend around and under the lip (**14**) causing the flange (**24**) to stretch thinner which allows the flexible tangs (**80**) and horizontal ribs (**82**) to pass by without pinching the flange (**24**).

The Harmony needleless access system of the present invention is designed to eliminate accidental needle sticks by doctors and nurses. This is possible because the drug can

be removed from the vial using a standard syringe without attaching a needle to it first.

The hub **(60)** will be assembled into the housing **(50)** in the up position or pre-activated position. The opening on the top **(51)** of the housing will be covered with a foil induction seal **(53)** that will keep the inside of the housing **(50)** and the hub **(60)** sterile prior to use. The foil **(53)** will be removed prior to activation. The drug companies will assemble the housing/hub assembly post filling and stoppering of the vials. Step 1: The doctor/nurse will activate the system by removing the foil induction seal from the top of the housing. Step 2: A standard luer lock syringe will be attached to the hub by turning the threaded portion of the syringe over the radial flanges of the hub, therefore locking the two components together (see page 3). Step 4: The syringe **(12)** will then be pushed forward to activate the system and locking the hub **(60)** onto the down or activated position (see page 4). The syringe **(12)** is then unlocked from the hub **(60)** by rotating in the counterclockwise direction and the contents can now be administered to the patient.

Even though particular embodiments of the present invention have been illustrated and described herein, it is not intended to limit the invention and changes and modifications may be made therein within the scope of the following claims.

What is claimed is:

1. A needleless access system adapted to be mounted on a vial comprising:

a generally elongated tubular housing having an interior dividing wall,

flexible hooks projecting upwardly from the dividing wall which are diametrically opposed;

a pair of confronting splines projecting upwardly from the interior dividing wall;

a hub insert having a piercing tip normally supported in an armed position by hook elements;

a series of outwardly projecting teeth which engage and are guided in the splines during axial displacement of the hub insert relative to the splined housing; and

said hub insert having means for mounting a syringe assembly whereby the hub insert maybe activated axially guided by the splines so that the piercing tip engages the stopper in a vial aligned therewith.

2. A system as claimed in claim 1 wherein said insert has a pair of axially spaced, radially outwardly projecting flanges which engage the flexible hooks in the unarmed position of the hub insert and are releasable therefrom when the hub insert is actuated axially to an armed position.

3. A system as claimed in claim 1 wherein said main housing has a series of circumferentially spaced, radially inwardly and upwardly extending tangs and a series of companion ribs spaced from the tangs to define a gap which engage under a buttress ring on the neck of a container to firmly seat the dividing wall against a stopper in the container and wherein the ribs engage in the spaces between the gear portions of the buttress ring to prevent rotation of the said housing relative to the vial.

* * * * *